JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

AND

AMERICAN REPERTORY.

DECEMBER, 1843.

## Civil Engineering.

*Cost of Transportation on Railroads.* By CHARLES ELLET, Jr., C. E.

(Continued from Page 324.)

*Repairs of Engines and Cars.*

It is the custom of many companies to publish the cost of repairs of their cars and engines in a single item, so as to make it impossible for the reader to determine, from their accounts, what portion of the bill was created by the engines, or the difference between the repairs due to different sorts of cars; but still an industrious investigation of the subject gives us facts enough to estimate these separate items for ordinary cases, with all desirable accuracy. I have stated in a former paper that the repairs of burthen cars are worth, on the average, 4½ mills per ton per mile; and that the repairs of the engines averaged, during the year 1842, *seven* cents per mile run. I have also observed that the repairs of passenger cars vary from three-fourths of a mill to a mill and a half, and sometimes exceed 2 mills per passenger per mile. If these facts—all of which enter into the formula which I have offered for the determination of the aggregate annual expenses of a railroad company—be well established, they will not only stand the test of trial for the aggregate, but they will apply in detail. Not only should the formula for determining the aggregate expenses be correct, and correspond with actual results—as we have seen—but the separate items of which it is composed, must, likewise, bear the test, and give results in agreement with the average results of experience.

It is not pretended that a formula could be offered which would show the exact cost of every item of every company for every year—because the actual expenditures due to each item fluctuate from year to year; but it is maintained that these fluctuations are above and below a certain average line, from which they may depart towards

either side for a certain time, but to which, and beyond which, on the opposite side, they are as sure to come as the pendulum is sure to approach the vertical in its vibrations. Although it was not my intention to enter so minutely into these details, probably more confidence will be yielded to my statements when the data on which they are founded are presented. These data, for the repairs of engines, are exhibited in the following

*TABLE.*

| Name of Roads. | Year | Miles run by engines. | Cost of repairs of engines. | Repairs pr mile run. | Remarks. |
|---|---|---|---|---|---|
| Philada. Wilm. & Balt. | 1842 | 177,859 | $ 17,071 | 9.6Cts. | Old Road. |
| Western Road, | 1842 | 397,295 | 24,177 | 6.1 | New road. |
| Georgia Road, | 1842 | 152,873 | 10,155* | 6.7 | Ordinary & extraord'y repairs & improvem's. |
| Balt. & Susquehanna, | 1842 | 128,349 | 7,193 | 5.6 | New road. |
| Utica and Schenectady, | 1842 | 150,000 | 10,346 | 6.9 | Passenger business. |
| Baltimore and Ohio, | 1841 | 299,617 | 20,640 | 7.0 | Old roads in good condition. |
| Baltim'e and Washing'n, | 1842 | 95,817 | 7,973 | 7.2 | |
| Philada. & Columbia, | 1842 | 261,744 | 21,915 | 8.4 | Generally frei't business. |
| Boston and Providence, | 1842 | 112,805 | 7,257 | 6.5 | Old roads in good condition. |
| Baltimore and Ohio, | 1843 | 509,765 | 35,941 | 7.0 | |
| Wash. and Baltimore, | 1843 | 96,716 | 6,714 | 7.0 | |
| | | 2,382,840 | $ 169,380 | Avr. 7.1 | |

This table exhibits the cost of repairs of engines which have traversed a space of 2,382,840 miles; and shows that the average is within one-tenth of a cent, per mile run, of the mean value at which I had stated it. It is my impression, however, that the average on these same roads will be greater for the year 1843.

Now, if we call N the number of miles traveled by the locomotive engines; T the number of tons of freight carried one mile; and P the number of passengers carried one mile, the average aggregate cost of repairs of passenger and burthen cars, and locomotive engines, will be shown, very nearly, by the formula,

$$\frac{7N}{100} + \frac{4.5T}{1000} + \frac{P}{1000}.$$

By expressing the cost of repairs in this way, we are able to determine, at once, the expenses of repairs for an entire train composed of either description of cars, or of both sorts, and in any proportions.

Although this, and all my other, estimates might be much strengthened, by bringing forward facts resulting from former experience, I prefer, with one or two exceptions, to limit my examples, on this occasion, to those works of which I have obtained authentic information for the year 1842. Of course, I exclude those lines which have been so recently completed, as to require no repairs at all for cars.

The following table presents the number of miles run by locomotive engines, and the number of tons and passengers carried one mile on eight railroads for the year 1842, and two for 1843—which have been

* This Company have added to the usual division of their expenses into ordinary and extraordinary repairs, the new classification of "improvements to engines;" not being able to conceive that a small stock of engines could run 153,000 miles, and be materially improved by it, I regard these "improvements" as *expenses*.

recently published;—and in the two last columns will be seen the actual expenses of repairs of cars and engines, and the expenses of the same computed by the formula.

*TABLE.*

| Name of Road. | Year | Miles run by engi's. | Tons carried one mile. | Passengers carried one mile. | Actual cost of repairs. | Comput'd cost of repairs. |
|---|---|---|---|---|---|---|
| Petersburg Road, | 1842 | 131,160 | 1,342,000 | 976,000 | $ 16,513 | $ 16,196 |
| Boston and Providence, | 1842 | 120,000 | 890,400 | 4,919,418 | 13,506 | 17,326 |
| Baltimore and Ohio, | 1841 | 299,617 | 3,647,093 | 2,495,911 | 45,534 | 39,881 |
| Baltimore and Ohio, | 1842 | 334,519 | 3,985,425 | 2,738,779 | 44,568 | 44,189 |
| Baltimore and Ohio, | 1843 | 509,765 | 7,109,310 | 6,062,455 | 62,862 | 73,738 |
| Baltim. and Washington, | 1843 | 96,716 | 805,429 | 2,646,719 | 17,453 | 14,801 |
| Baltimore and Susque'a., | 1842 | 128,349 | 1,610,000 | 1,165,000 | 13,370 | 17,390 |
| Balt. and Washington. | 1842 | 95,817 | 877,138 | 3,188,948 | 17,053 | 13,864 |
| Utica and Schenectady, | 1842 | 150,000 | | 8,413,704 | 18,842 | 18,914 |
| Boston and Lowell, | 1842 | 143,607 | 2,442,102 | 4,675,294 | 28,816 | 25,716 |
| Georgia Road, | 1842 | 152,873 | 1,475,000 | 1,770,000 | 19,899 | 19,107 |

On inspecting this list we will observe that the actual charges on some of the roads are a little above, and on others a little below, the indications of the formula—but that the deviations are in no instance too wide to render the rule, as far as it goes, a safe test of the value of an investment. The actual cost on the Baltimore and Ohio Railroad falls considerably below the computed cost for the year 1843. In 1842 the agreement was very close, and in 1841 the result was nearly as much above as that of 1843 is below the rule. Indeed, in 1841 the sum of $ 9,766 was expended for *new* burthen and passenger cars, in addition to the $ 45,534 charged to repairs of cars and engines. The aggregate expenses for repairs of cars and engines, on that work, for the three years amounted to $ 152,964—and the expenses calculated by the formula to $ 157,808. If we add the sum paid for *new cars*, to the actual cost of repairs, the actual expenses, for the three years, will be $ 162,730, or 3 per cent. above the computed expenses.

The formula simply exhibits what it is intended to show—the average for a succession of years. I do not include the Boston and Worcester road in this table, because the result on that work is entirely anomalous. For previous years the agreement between the calculation and expenses was sufficiently close; but in 1842 there was a material increase of business, an extraordinary reduction in the expense of repairing the cars and engines, and a simultaneous augmentation of the capital—or charge for construction—of $ 390,000. I am obliged to suppose that new cars and engines were added to the line, and that a portion of the business was performed by new stock.*

We may now pass to another very important division of railroad expenses, which are usually, though very improperly, denominated "extraordinary expenses." I refer chiefly to the

*Wear of Iron Rails.*—There is, perhaps, no subject of interest to

* The cost of repairs of locomotive engines for this road, for the year 1841, was 9½ cents per mile run, and in a space of seven years, from 1835 to 1841 inclusive, the engines performed an aggregate distance of 850,809 miles, at an aggregate cost of $ 84,183; or within a fraction of 10 cents per mile run. The repairs of cars are fluctuating, but the average is in accordance with the formula. This road is not an exception to the rule, though the formula does not apply for the year 1842.

the engineer which has attracted less serious attention, or has been more vaguely and indefinitely considered, than the wear of railroad iron. Instead of attempting to find some correct and rational measure of this wear, the public, and in a great measure, the profession also, have persisted in regarding the visible destruction of the iron on roads which have been some years in operation, as a consequence of the inferior quality of the particular specimen, or of the inadequate strength of the particular pattern. It is the custom to say that the mashed and splintered iron of the Camden and Amboy, and Columbia roads was bad; but no argument has ever been adduced to show that good iron, in the same situation, and subjected to the same sort of treatment, would do better.

So long as railroads happened to occupy positions where they would be used for the mere conveyance of the travel, and a few thousand tons of goods, between adjacent cities, the durability of iron was a question of subordinate interest. An engineer could be satisfied that his rail would last 10 or 20, or 30, years, and could generally count on a sufficient increase of business consequent on the increase of population, to compensate for its destruction in that space of time. But railroads are now projected to take the place of important canals, and to furnish the means of transport for the heavy products of the earth at exceeding low rates. The question assumes, therefore, another aspect. The trade of the Erie canal in New York, and of the Schuylkill Navigation in Pennsylvania, may be estimated at 700,000 to 1,000,000 tons per annum; and there is no railroad in the United States worked by steam power, which accommodates more than the one-ninth, or one-tenth, of this amount, with the exception of the Reading railroad, which has not yet been long enough in operation to yield any useful practical results.

The common half-inch flat bar, under ordinary circumstances, is adequate to the transportation of about 150,000 tons of freight. Such a bar on the Petersburg road, where the freight amounts to some 25,000 tons, would resist the wear of six years' business; but if one year's trade of the Schuylkill canal were poured along it, the iron part of the track would need entire renewal *six times in one year.*

The same remark is applicable to any of the same sort of wooden roads in the country. They would all bear about 150,000 tons net, drawn at the usual speed of ordinary freight engines, but would be completely destroyed by about *five weeks' business* of the Schuylkill Navigation, in the season of active trade.

It must be admitted that we have not yet sufficient data for estimating, with entire certainty, the probable durability of many varieties of rails. We have, however, data sufficient, if we use it properly, to make a much nearer approximation than is generally supposed to be practicable. The durability of the half inch plate rail can be determined with all desirable accuracy, and we can judge from analogies, which the problem presents, the probable wear of other patterns. Great errors have been committed in the consideration of this subject, by overlooking the fact that the progress of the wear is rarely ascer-

tained, or, in the least, appreciated, until the rail is destroyed. The annual charge for iron is very small, because, in general, the track does not appear to give way until it is nearly unfit for use. When repairs really commence, the destruction is so far advanced that the iron must be renewed; and if the directors assert, as they usually do, in their next report to the stockholders, that experience has shown that the original iron was very bad, and has all been crushed, the explanation is satisfactory, and the cost of the new iron is forthwith charged to the account of construction.

We accordingly find, in looking through the reports of railroad companies, that the average annual increase of capital, generally exceeds the dividends even of the most successful enterprizes; and *there is not now to be found in the country a single road which has renewed its iron out of the proceeds of transportation.* While the trade continues to be small, and this extraordinary outlay is needed but once every 6 or 8 years, the self-deception can be practiced with considerable success. But there are now works constructed which are intended for a very great business, and which will reduce the extraordinary charge for renewal of iron down to a very ordinary circumstance. The Reading Railroad is contemplated for the conveyance of the present trade of the Schuylkill Canal—from seven to eight hundred thousand—and which will very soon reach one million of tons—and should the experiment succeed, *the cost of iron will be more than equal to the entire renewal of a single track every year.* The question of wear, is, therefore, of immense importance, and can no longer be lightly disposed of by companies of this class.

This, as every other item of railroad expenses, is subject to a certain law, which must be recognized before we can make any effectual progress in our investigation.

The destruction of iron depends on the grades of the road, on the tonnage, and on the travel. Every ton of freight that passes produces a certain amount of injury; every passenger car and every passenger does some injury, and every engine that traverses the line produces its share of mischief; but the number of engines that traverse the road, in conveying a given amount of tonnage, depends on the limiting gradient—and, consequently, the destruction of iron, *cæteris paribus*, is greatest on those roads of which the grades are most unfavorable to the useful effect of the power.

If we call N the number of miles traveled by all the engines on the line; T the number of tons net conveyed one mile; and P the passengers conveyed one mile, for one year, then

$$a\,N + b\,T + c\,P,$$

will be the form of the expression which represents the amount of injury which the iron has sustained—*a*, *b*, and *c*, being constants to be supplied by experiment. It is assumed, of course, that the weight and form of the rail, as well as the weight, construction, and velocity of the engines, are uniform.

The point, now, is to determine the values of the coefficients, *a*, *b*, and *c*. For this purpose I take, in the first place, a road on which

engines are not used, and but few passengers are conveyed. The wear of iron on such a road gives us the value of $b$, or the injury done by the tonnage.

There are two works of this description of which we can find published reports, and which have been long enough in activity to destroy a portion, or the whole, of their iron.

The *Chesterfield Railroad*, in Virginia, constructed with a flat bar, and using horse power and light cars, has required, for some years past, about $200 per mile for new iron, to replace that which is destroyed by the passage of an average trade of about 50,000 tons of coal. The destruction is here equivalent to *four mills* per ton per mile.

The *Mine Hill and Schuylkill Haven Railroad* was originally constructed with a flat bar, and six miles in length of the road had been renewed with a heavy edge rail, before 400,000 tons had passed along it. Assuming the value of the flat bar at $60 per ton, or $1200 per mile, which is below its present value, and that the iron was worn out by 400,000 tons, the result will be three mills per ton per mile. But this road is provided with a double track, and the track which was destroyed was not used by the ascending cars.

The injury produced by the empty cars is certainly more than one-third of that effected by those which are loaded; and the result on this road, therefore, corresponds very closely with the previous example. The wear then obviously will not be less than 4 mills on a road sustaining locomotive power—where the velocity is much greater than on the Chesterfield and Mine Hill roads.

I will not, therefore, be above the mark in assuming $b = 4$ mills.

The flat bar on the *Petersburg Road* may be considered to have been worn out in six years, by use which was equivalent to 12,000 trips of locomotive engines; 130,000 tons of freight, and 100,000 passengers carried over each mile. If we consider the injury caused by cars carrying 5 passengers, equal to that produced by those carrying 1 ton of freight, and the value of this iron equal to $1200 per mile, we shall have

$$b\,\mathrm{P} + c\,\mathrm{T} = \$600$$

for the damage due to the freight and passengers.

The remaining sum of $600 is the destruction produced by the 12,000 miles run by the locomotive engines; whence we have

$$a = \frac{60.000}{12,000} = 5 \text{ cents};$$

or 5 cents for the injury done by the passage of the locomotive engine over every mile of the road.

We obtain, then, from this procedure, $a = 5$ cents; $b = 4$ mills; and $c = \frac{4}{5}$ mill, and for our formula

$$\frac{5\,\mathrm{N}}{100} + \frac{4\,\mathrm{T}}{1000} + \frac{4\,\mathrm{P}}{5000}.$$

If these values be correct they will apply to any other similar case

The first iron used on the South Carolina Road, was destroyed in less than six years—after it had borne about 130,000 through tons, and 120,000 through passengers, and the locomotive engines had made 10,000 through trips. The formula will give for this case,

$$\frac{10{,}000 \times 5}{100} + \frac{130{,}000 \times 4}{1000} + \frac{120{,}000 \times \frac{4}{5}}{1000} = \$\,1{,}116$$

for the destruction of the iron per mile. This is, no doubt, very near the true value of the first iron used on that road, estimated at the present prices.

There are several other roads, of both descriptions, for which similar computations might be made, and which would confirm the estimate—and I shall take occasion, at a subsequent period, to present much data of the same character in a tabular form. But without discussing this branch of the subject further, at present, it may be stated in round numbers, that the average destruction of the half inch plate rail, caused by engines, freight, and passengers, is equal to about 8 *mills per ton net per mile;* and by comparing the above expression of the wear of the rail, with that previously obtained for the wear of the cars and engines, we will perceive that they possess very nearly the same value—or that the injury done to this iron, by the passage of a train, is but about 10 per cent. less than the wear and tear of the engine and cars composing the train.

In the application of this formula, however, the fact is not to be overlooked, that it is derived from the destruction of the plate rail, and is intended only to be applied to that description of road. *The destruction of any form of* T *or* H *rail, which I have yet seen, will be greater.* It is true that the expenses of maintenance for some new roads, provided with heavy iron, are yet very light, and they will possibly continue to be light until they have carried from three to five hundred thousand tons of freight—when, if the rail is still in existence, they will be very heavy.

It requires but little experience, and no speculation, to bring us to this conclusion. Let us take the two patterns, fig. 1, and fig. 2, for the purpose of illustration. Fig. 1, is a common form of edge rail, of 60 pounds per yard, of which the head, or upper table, A, weighs 20 pounds. Fig. 2, is a common plate rail, 2½ inches wide, by ⅞ of an inch thick, which also weighs about 20 pounds.

This flat bar is supported along its whole length and breadth by the wooden string, S, and the edge rail is supported only in the centre by the vertical stem, P. Is there now any reason why the unsupported flanch, *f*, should do more service than the supported flat bar, B? The vertical stem and base of fig. 1 never wear out; it is the head of that rail which is crushed and rolled to pieces. When the rail

is destroyed the lower portions are untouched; but when the head is bruised and split, the whole rail is rendered useless—and when the rail is ruined, 60 pounds of iron per yard, are lost to the company. The flat bar will bear just as much—indeed, being supported, a little more—hammering, and when it is destroyed, but twenty pounds are lost. Besides it may be welded when broken, the ends may be "upset," and restored when split; new holes, when necessary, may be punched, and it can be returned to the road until the lamination and splintering throughout render it wholly unfit for useful service.

But it is not my intention to speculate here on the relative merits of rails. The present object is to adduce facts and conclusions based on observation of many roads of various descriptions, in relation to the destruction of such rails as are ordinarily adopted. I know that my opinions on this head are not those of the public, nor of many professional gentlemen of much experience; but I believe they are, nevertheless, correct, and I therefore submit them to a test which will speedily be applied, and by which this question will be most conclusively settled.

The rails of the Reading road are, by common consent, acknowledged to be good; the pattern is considered, by the advocates of edge rails, to be unexceptionable; and the mode of manufacture adopted—that of making the lamina horizontal—is considered to render them almost proof against wear.

In regard to these rails—with all their merits, and all their superiority—I affirm,

1st. That they will not withstand the rolling of the trade of the Schuylkill valley for one year.

2nd. That before 800,000 tons of coal have passed down, and the empty cars have been returned on them, the present track will be entirely unfit for safe usage.

3rd. That it will cost from 50 to 75 cents to replace the iron which is destroyed by each ton of coal that descends from Pottsville to Richmond, on the present track. And,

4th. That before next August, if the company succeed in obtaining the trade which they desire, this rail will be pronounced *too light* by the very parties who now think it will last forever.

The fault, however, is less in this particular rail than in *iron*, which is not tough enough for such usage at such prices.

I know that the *Providence road* will be adduced as evidence against me, where the road has been some six years in use, and the iron is yet sound; but the Providence road actually passes but 30,000 tons per annum on a single track, and must yet stand 25 years before it can do one year's business of the Schuylkill canal.

The *Georgia road* may, perhaps, be quoted as evidence, where *experience*, they say, has demonstrated, beyond all question, the ability of railroads to compete with canals, for the conveyance of heavy freight; but the Georgia railroad has been less than three years in operation, and has *not yet carried as much freight as has sometimes passed along the Schuylkill canal in three days.* Pour the trade of the Schuylkill, or Erie, canal, on parts of that road, with

such engines as would be needed for its conveyance, and the track would be crushed in less than four weeks.

The *Boston and Lowell road* will be quoted. This road has not yet carried, in the eight years of its existence, an aggregate tonnage equal to the Schuylkill trade—and that tonnage has been sufficient for the destruction of the first track of edge rail, and the company are now, and have been for some time, using the second and third tracks.*

The *Camden and Amboy road* was originally provided with a "permanent" track. The aggregate trade has not yet reached 300,000 tons net—the reader who feels any interest in such matters can cross the Delaware to Camden, and examine the old rails, and form his own conclusions; he will then be able to judge whether these have given out because they are too weak, or because the material, in this form, is inadeqate to a much greater effort.

In *England*, however, it is contended, people have more experience. The *best* experience there, is that of the Liverpool and Manchester Railroad, a work which was opened to public use in the fall of 1830. This road was at first supplied with two tracks of edge rails, weighing 35 pounds per yard. The rail answered very well until the fall of 1833, when the work had passed about 300,000 tons on each track, at which period £150 were expended for *new rails*. In the next half year, before they had transported 350,000 tons, an additional outlay of 3000 pounds sterling was required for new rails, and the adopted pattern was pronounced *too light* for the service. A rail weighing 50 pounds per yard was next tried, and subsequent experience showed that that also was *too light*. A new pattern was then projected, weighing 62 pounds per yard, and forthwith submitted to the same rough usage. The trade on this road is great, and soon tests the merit of a fancy. This pattern was also found inadequate, and another, weighing 70 pounds per yard, was fixed upon, which was, *last year*, regarded as the pattern rail. I have not yet heard how it wears, but one year more will test its strength on that road, where there is really a heavy trade, although the net tonnage does not reach one-half, nor much exceed one-third, of the average trade of the Schuylkill, or Erie, canals. I do not believe that either pattern would resist the action of one year's business of one of those works, if it were confined to a single track.

I trust that those who have made observations on this interesting subject, will communicate them for publication in this journal. If there be an edge rail in the United States, which has sustained the passage of a million of tons of freight,† conveyed by locomotive engines, it could not but be regarded as a most encouraging circumstance, and its history ought to be known; such a rail—weighing 60 pounds per yard—would show the practicability of reducing the average cost of

* It is proper to say that the rails of this road were taken up after six years' use, because they were too weak; but we never meet with rails that are *strong enough* after they have sustained the passage of 600,000 tons.

† In a report on Herron's cast-iron rails laid before the Committee on Science and the Arts of the Franklin Institute, about two years ago, I stated that no road in the United States had yet sustained one million of tons of freight: I have not yet heard of such an instance.

this item for such rails down to 6 mills per ton per mile; and, therefore, below any result which I have yet been able to obtain. My impression is, from the comparisons of the actual destruction which I have been able to make, that its value may be reduced, by the adoption of a suitable flat bar, and a moderate speed, to 3½, or 4, mills per ton per mile.

(To be continued.)

---

*Experiments on Water-Wheels, having a vertical axis, called Turbines.* By Arthur Morin, C. A., P. M. S. A., &c. &c.

(Translated from the French, by Ellwood Morris, Civil Engineer.)

[Continued from Page 302.]

## XXV.

### *Observations on the emission of the water by the openings of the Turbine.*

It remains for us to make known some results of particular observations on the mode of gauging adopted at Müllbach, for estimating the expenditure of water made during the experiments.

Our design in uniting these results was to know if it were possible to determine, for each lift of the sluice-gate, the value of the coefficient of the discharge made by the openings of the turbine, in order to be able to calculate directly the volume of water vented by these orifices, in cases where it would not be possible to establish direct modes of gauging; but we must, nevertheless, premise, that not having been able to give to the means of observation sufficient precision, we have not pretended to arrive at results, comparable for exactness, with those which have been obtained either at Metz, or Toulouse, and that we solely propose to establish the approximate values, and to examine the influence of the velocity of the wheel, and of the size of the openings. Knowing, for each experiment, the volume of water discharged, the lift of the sluice-gate, the sum of the horizontal breadths of the orifices, or the shortest distances between the curved guides of the sluices, equal to (1.56 m.) 5 $\frac{12}{100}$ feet, we have compared the theoretical expense, made under the known difference of the upper and lower levels, to the effective expense, (or actual discharge of water,) and we have by it deduced the corresponding value of the coefficient of the discharge; [or that constant number, which, multiplied by the known areas of the openings, and by the theoretical velocity of the water due to the fall, gives the actual discharge.—Tr.]

The results of this comparison are recorded in the following table, which shows at once that the coefficient increases with the velocity of the wheel; this is a consequence of the action of the centrifugal force diminishing the pressure exerted below in the orifices, and tends consequently, to augment the discharge; but as the immediate results of the experiments do not offer all the regularity desirable for observations on the emission of the water, we have sought another way to unite them, and by it to deduce a kind of general law, by representing them by the curves, Figs. 9, 10, 11, 12, and 13, Plate II, of which the abscisses are the number of turns of the wheel in a minute, and the ordinates the coefficients of the discharge deduced from calculation.

*Observations on the emission of water by the sluices of the Turbine of Müllbach = outer diameter 2 metres, inner diameter about 1.6 metre; circumference, inner circle = 5.024 metres.*

| Number of the experiments. | Sum of the areas of the orifices. | Lift of the sluice-gate of the turbine. | Charge of water, or difference of the levels, above and below. | Number of turns of the wheel in one minute. | Discharge of water in a second. | | Coefficient of the discharge. | Theoretical velocity of the water per second. | Velocity of the wheel at the inner circle, per second. | Ratio of the velocity of the wheel at the inner circle, to the theoretical velocity of the water per second. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theoretical. | Actual. | | | | |
| | Sq. m. | Metres. | Mtrs. | No. | M. cub. | M. cub. | | Metres. | Metres. | |
| 1 | 0.078 | 0.050 | 3.552 | 72. | 0.650 | 0.623 | 0.957 | 8.35 | 6.02 | 0.721 |
| 2 | " | or | 3.547 | 67.9 | 0.650 | 0.628 | 0.957 | 8.35 | 5.68 | .680 |
| 3 | " | .050 | 3.560 | 64.8 | 0.651 | 0.623 | 0.956 | 8.36 | 5.42 | .648 |
| 4 | " | .330 | 3.580 | 63.1 | 0.654 | 0.623 | 0.953 | 8.38 | 5.28 | .630 |
| 5 | " | 10-66ths | 3.580 | 60.0 | 0.654 | 0.523 | 0.953 | 8.38 | 5.02 | .600 |
| 6 | " | of whole | 3.565 | 57.6 | 0.651 | 0.623 | 0 956 | 8.36 | 4.82 | .577 |
| 7 | " | height | 3.555 | 55.3 | 0.650 | 0.611 | 0 940 | 8.35 | 4.63 | .554 |
| 8 | " | 0.333 m. or | 3.565 | 53.3 | 0.651 | 0.611 | 0.938 | 8.56 | 4.46 | .533 |
| 9 | " | 15-100ths | 3.580 | 50.7 | 0.654 | 0 611 | 0.935 | 8.38 | 4.24 | .506 |
| 10 | " | of 0.333 m. | 3.585 | 47.6 | 0.654 | 0.610 | 0.933 | 8.38 | 3.94 | .470 |
| 11 | " | or 1-100th | 3.621 | 43.9 | 0 657 | 0 610 | 0.930 | 8.43 | 3.67 | .435 |
| 12 | " | of the cir- | 3.621 | 40.9 | 0.657 | 0.610 | 0.930 | 8.43 | 3.42 | .406 |
| 13 | " | cumfer'ce | 3.650 | 37.5 | 0.660 | 0.610 | 0.925 | 8.46 | 3.14 | .371 |
| 14 | " | of inner | 3.680 | 34.25 | 0 661 | 0.610 | 0.923 | 8.50 | 2.86 | .327 |
| 15 | " | circle. | 3.703 | 31. | 0.665 | 0.623 | 0.935 | 8.52 | 2.59 | .303 |
| 16 | " | | 3.725 | 28.1 | 0.666 | 0.623 | 0.933 | 8.54 | 2.35 | .275 |
| 17 | " | | 3.730 | 26.85 | 0.667 | 0.623 | 0.931 | 8.55 | 2.24 | .262 |
| 18 | " | | 3.750 | 21.7 | 0.668 | 0.623 | 0.935 | 8.58 | 1.82 | .212 |
| 19 | 0.1404 | 0.090 | 3.224 | 75. | 1.112 | 1.156 | 1.039 | 7.95 | 6.28 | .790 |
| 20 | " | or | 3.199 | 69. | 1.109 | 1.087 | 0.990 | 7.92 | 5.77 | .729 |
| 21 | " | .09 | 3.208 | 65. | 1.110 | 1.101 | 0.993 | 7.93 | 5.45 | .687 |
| 22 | " | .333 | 3.210 | 61.6 | 1.110 | 1.071 | 0.996 | 7.94 | 5.15 | .649 |
| 23 | " | 27-100ths | 3.196 | 59.2 | 1.109 | 1.071 | 0.965 | 7.93 | 4.96 | .625 |
| 24 | " | of whole | 3.177 | 56. | 1.105 | 1.071 | 0.972 | 7.90 | 4.69 | .594 |
| 25 | " | height | 3.190 | 52. | 1.109 | 1.036 | 0.936 | 7.91 | 4 35 | .550 |
| 26 | " | 0.333, or | 3.190 | 49.2 | 1.109 | 1.016 | 0.917 | 7.91 | 4.12 | .521 |
| 27 | " | 18-100ths | 3.207 | 45.25 | 1.119 | 1.016 | 0.916 | 7.94 | 3.79 | .477 |
| 28 | " | of circumf. | 3.207 | 41. | 1.110 | 1.016 | 0.916 | 7.94 | 3.43 | .432 |
| 29 | " | of inner | 3.213 | 37.2 | 1.110 | 1.008 | 0.908 | 7.91 | 3 11 | .392 |
| 30 | " | circle, or | 3.225 | 35. | 1.112 | 1.008 | 0.906 | 7.95 | 2.93 | .369 |
| 31 | " | 27-100ths | 3.265 | 32.5 | 1.120 | 0.971 | 0.869 | 8.00 | 2.72 | .340 |
| 32 | " | of whole | 3.305 | 29 5 | 1.177 | 0.971 | 0.827 | 8.05 | 2.47 | .307 |
| 33 | " | height. | 3.295 | 27.5 | 1.175 | 0.976 | 0.831 | 8.04 | 2.30 | .286 |
| 34 | 0.2340 | 0.150 | 3.164 | 99.5 | 1.840 | 1 881 | 1.022 | 7.88 | 8.33 | 1.057 |
| 35 | " | or | 3.164 | 92.0 | 1.840 | 1.786 | 0.972 | 7.88 | 7.70 | .977 |
| 36 | " | 45-100ths | 3.150 | 90.0 | 1.839 | 1.781 | 0.960 | 7.86 | 7.54 | .959 |
| 37 | " | of whole | 3.153 | 83.5 | 1.839 | 1.751 | 0.954 | 7.86 | 6.99 | .890 |
| 38 | " | height; | 3.110 | 78.5 | 1.825 | 1.747 | 0.957 | 7.81 | 6.57 | .841 |
| 39 | " | | 3.070 | 73.0 | 1.815 | 1.766 | 0.974 | 7.76 | 6.11 | .787 |
| 40 | " | | 3.070 | 69.0 | 1.815 | 1.666 | 0.917 | 7.76 | 5.77 | .744 |
| 41 | " | | 3.075 | 63.0 | 1.815 | 1.641 | 0.905 | 7.76 | 5.27 | .679 |

*Observations, &c.—Continued.*

| No. of the experiments. | Sum of the areas of the orifices. | Lift of the sluice-gate of the turbine. | Charge of water, or difference of the levels, above and below. | Number of turns of the wheel in one minute. | Discharge of water in a second. | | Coefficient of the discharge. | Theoretical velocity of the water per second. | Velocity of the wheel at the inner circle per second. | Ratio of the velocity of the wheel at the inner circle, to the theoretical velocity of the water, per second. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theoretical. | Actual. | | | | |
| | Sq. Mt. | Metres. | Mtrs. | No. | M. cub. | M. cub. | | Metres. | Metres. | |
| 42 | 0.2340 | 0.150 | 3.035 | 58.25 | 1.800 | 1.586 | 0.883 | 7.71 | 4.87 | .631 |
| 43 | " | or | 3.085 | 52.0 | 1.820 | 1.576 | 0.867 | 7.78 | 4.35 | .559 |
| 44 | " | 30-1000ths | 3.085 | 48.0 | 1.820 | 1.561 | 0.859 | 7.78 | 4.02 | .517 |
| 45 | " | of the cir- | 3.085 | 44.0 | 1.820 | 1.526 | 0.840 | 7.78 | 3.68 | .473 |
| 46 | " | cumference | 3.380 | 45.3 | 1.900 | 1.652 | 0.872 | 8.14 | 3.79 | .466 |
| 47 | " | of the inner | 3.272 | 38.0 | 1.873 | 1.528 | 0.817 | 8.01 | 3.18 | .397 |
| 48 | " | circle. | 3.400 | 38.5 | 1.909 | 1.528 | 0.801 | 8.17 | 3.22 | .394 |
| 49 | " | | 3.405 | 34.4 | 1.909 | 1.528 | 0.798 | 8.17 | 2 88 | .353 |
| 50 | 0.3120 | 0.200 | 3.020 | 104. | 2.402 | 2.053 | 0.854 | 7.70 | 8.70 | 1.130 |
| 51 | " | or 60-100ths | 3.045 | 103. | 2.404 | 2.033 | 0.860 | 7.73 | 8.62 | 1.115 |
| 52 | " | of the whole | 3.080 | 101.5 | 2.422 | 2.025 | 0.847 | 7.77 | 8.49 | 1.092 |
| 53 | " | height, or | 3.120 | 95 | 2.443 | 2.003 | 0.822 | 7.83 | 7.95 | 1.015 |
| 54 | " | 40-1000ths | 3.170 | 90.4 | 2.464 | 1.993 | 0.809 | 7.89 | 7.57 | .959 |
| 55 | " | of circum- | 3.190 | 87.1 | 2.470 | 1.951 | 0.807 | 7.91 | 7.29 | .921 |
| 56 | " | ference of | 3.203 | 82.8 | 2.472 | 1.913 | 0.766 | 7.93 | 6.93 | .874 |
| 57 | " | the inner | 3.240 | 80. | 2.490 | 1.913 | 0.768 | 7.97 | 6.70 | .841 |
| 58 | " | circle. | 3.255 | 75. | 2.491 | 1.913 | 0.768 | 7.99 | 6.28 | .786 |
| 59 | " | | 3.270 | 70. | 2.500 | 1.913 | 0.767 | 8.01 | 5.86 | .731 |
| 60 | " | | 3.305 | 67.6 | 2.509 | 1.913 | 0.765 | 8.05 | 5.66 | .703 |
| 61 | " | | 3.310 | 67.1 | 2.512 | 1.913 | 0.759 | 8.06 | 5.62 | .697 |
| 62 | " | | 3.310 | 63. | 2.512 | 1.872 | 0.747 | 8.06 | 5.27 | .654 |
| 63 | " | | 3.335 | 58. | 2.522 | 1.872 | 0.742 | 8.09 | 4.86 | .601 |
| 64 | " | | 3.306 | 50.6 | 2.509 | 1.812 | 0.722 | 8.06 | 4.24 | .526 |
| 65 | " | | 3.286 | 48.5 | 2.502 | 1.812 | 0.724 | 8.03 | 4.06 | .505 |
| 66 | " | | 3.321 | 44. | 2.520 | 1.812 | 0.720 | 8.07 | 3.68 | .456 |
| 67 | " | | 3.610 | 100. | 2.622 | 2.173 | 0.829 | 8.42 | 8.27 | .994 |
| 68 | " | | 3.650 | 97. | 2.642 | 2.082 | 0.790 | 8.46 | 8.12 | .960 |
| 69 | " | | 3.560 | 91. | 2.607 | 2.143 | 0.805 | 8.36 | 7.62 | .912 |
| 70 | " | | 3.475 | 87. | 2.570 | 2.083 | 0.815 | 8.25 | 7.28 | .882 |
| 71 | " | | 3.300 | 80. | 2.620 | 2.061 | 0.788 | 8.04 | 6.69 | .832 |
| 72 | " | | 3.250 | 72. | 2 493 | 1.983 | 0.796 | 7.99 | 6.03 | .755 |
| 73 | " | | 3.230 | 67. | 2.483 | 1 943 | 0.782 | 7.96 | 5.61 | .706 |
| 74 | " | | 3.358 | 62.1 | 2.715 | 1.963 | 0.710 | 8.11 | 5.19 | .640 |
| 75 | " | | 3 343 | 57.1 | 2.710 | 1.908 | 0.702 | 8.10 | 4.78 | .590 |
| 76 | " | | 3.393 | 54. | 2.548 | 1.863 | 0.733 | 8.15 | 4.52 | .554 |
| 77 | " | | 3.398 | 49.4 | 2.542 | 1.863 | 0.733 | 8.16 | 4.12 | .505 |
| 78 | 0.4212 | 0.270 | 2.990 | 90.6 | 3.230 | 2.523 | 0.782 | 7.66 | 7.58 | .989 |
| 79 | " | or 81-100ths | 3.070 | 87. | 3.207 | 2.523 | 0.773 | 7.76 | 7.28 | .938 |
| 80 | " | of the whole | 3.170 | 84.6 | 3.320 | 2.442 | 0.737 | 7.89 | 7.08 | .897 |
| 81 | " | height, or | 3.180 | 77.25 | 3.240 | 2.442 | 0.757 | 7.90 | 6.47 | .819 |
| 82 | " | 54-1000ths | 3.310 | 69. | 3.540 | 2.442 | 0.691 | 8.06 | 5.77 | .716 |
| 83 | " | of circum. of | 3.475 | 66.1 | 3.470 | 2.523 | 0.730 | 8.25 | 5.54 | .671 |
| 84 | " | inner circle. | 3.390 | 61.5 | 3.430 | 2.445 | 0.712 | 8.16 | 5.14 | .630 |

1st Series ○. 2nd Series +.

Fig. 7.

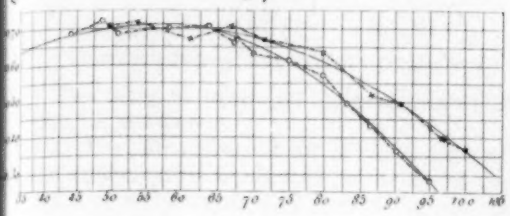


Fig. 8.

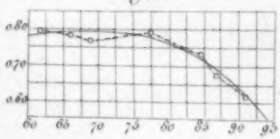


Fig. 9.

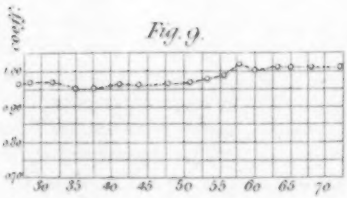


Fig. 10.

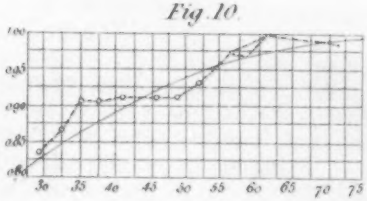


Fig. 11.

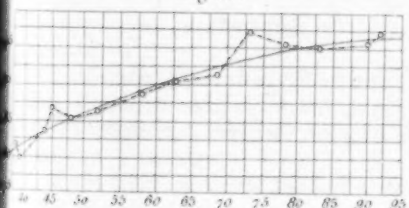


Fig. 13.

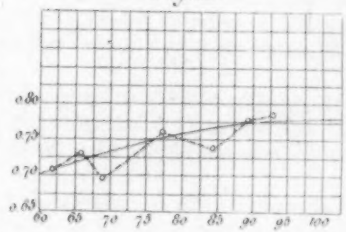
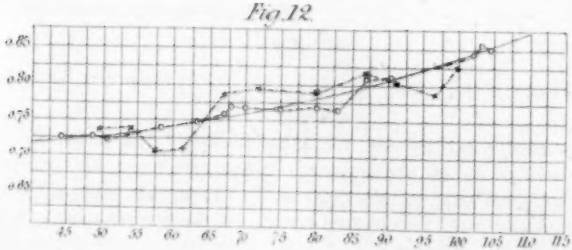


Fig. 12.



[NOTE.—The three last columns of this table have been added by approximation, so as to show, nearly, the relative velocities of the wheel at the inner circle, and that which theory assigns to the water under the several falls stated.—Tr.]

## XXVI.

*Consequences of the results contained in the preceding table.*

This table, or rather an examination of the foregoing curves, figs. 9 to 13, shows:—

1. That for the small lift of sluice-gate of (0.050 m.) $\frac{16}{100}$ of a foot, the coefficient of the discharge, or which comes to the same, the expense of water made in a second, by the orifices of the turbine, increased a little, with the velocity of the wheel, but so slowly that its mean value, from 20 unto 55 turns in a minute, is equal to about 0.93, and that it rises gradually with the velocity up to the value 0.96, when it reaches about 65 turns in a minute.

2. That at a lift of sluice-gate of (0.09 m.) $\frac{29}{100}$ of a foot, the coefficient of the discharge, which is about 0.93, at the velocity of 25 turns in a minute, rises very rapidly with the velocity, and reaches with about 75 turns in a minute the value 1.039, which shows that the effective discharge will be greater than the theoretical discharge.

3. That at a lift of sluice-gate of (0.150 m.) $\frac{49}{100}$ of a foot, this coefficient, which had only the value of 0.80, at the velocity of 34 turns in a minute, reached, and also exceeded that of *unity*, at the velocity of 99½ turns in a minute.

4. That at a lift of sluice-gate of (0.200 m.) $\frac{65}{100}$ of a foot, this coefficient, which had only the value of 0.72, at the velocity of 45 turns in a minute, reached that of 0.85, at the velocity of 102 turns in a minute.

5. Finally, that at a lift of the sluice-gate of (0.270 m.) $\frac{88}{100}$ of a foot, the same coefficient which had the value of 0.71 at the velocity of 75 turns in a minute, reached that of 0.76 at the velocity of 106 turns in a minute.

From these it results evidently that the discharge of water made by the turbines, increases with their velocity of rotation, and, moreover, as the effect of the centrifugal force to which this increase is due, depends on the proportions of the wheel, it follows that we shall be able to establish, in each case, a discussion of these proportions, by comparing the effects to the cause.

## XXVII.

*Influence of the height of the Lift of the Sluice-gate on the discharge.*

The curves of the coefficients show us also that these numbers, at equal velocities, are incessantly diminishing in proportion as the lift of the sluice-gate increases. We can verify this by examining the following table, in which we have combined the relative values at the different velocities and lifts of the sluice-gate, deduced from the mean trace of these curves.

| No. of turns of the wheel per minute. | Value of the coefficients of the discharge, for the following lifts of sluice-gate. | | | |
|---|---|---|---|---|
| | 0.090 m. | 0.150 m. | 0.200 m. | 0.270 m. |
| 40 | 0.905 | 0.820 | | |
| 50 | 0.945 | 0.862 | 0.728 | |
| 60 | 0.975 | 0.900 | 0.743 | |
| 70 | 0.995 | 0.930 | 0.762 | 0.706 |
| 80 | | 0.953 | 0.784 | 0.720 |
| 90 | | 0.968 | 0.812 | 0.746 |
| 100 | | 0 980 | 0.840 | 0.767 |

[NOTE.—We have not comprised in this table the coefficients relative to a lift of the sluice-gate of 0.050 m., because under the ratio sought, it did not admit of showing the diminution which is here the question.]

This diminution of the coefficient of the expense of water, in proportion as the lift of the sluice-gate augments, belongs evidently to the disposition of the orifices, and seems to us easy to explain, from the facts known of the emission of water by ajutages of many forms.

In effect, from the manner in which the orifice is disposed, the two contiguous curves forming the vertical walls give it, in this sense, a form analogous to that of casks, where the ajutages converge; the lower side is found in the prolongation of the bottom, and the upper side is the lower one of the cushion of wood that rises with the sluice-gate. It follows that for small lifts of sluice-gate the water issues by a true ajutage conic laterally, and with faces parallel on the vertical sides, and for which the contraction, at the entrance, is nearly null. It is not then astonishing that in that case the coefficient of the discharge attains a value equal, and even superior, to 0.90, since we know (Traité d'Hydraulique de M. d'Abuisson, p. 54,) that for conic converging ajutages, this number acquires, according to the inclination of the sides of the cone, similar values.

In proportion as the lift augments, the influence of the cushion for diminishing the contraction of the entrance of the ajutage, becomes less, because in spite of the rounding of its lower border, it has not the exact form of the fluid vein, and as the volume of water expended augments, the velocity in the interior pipe becomes greater, in consequence of the convergence of the fillets near the orifice.

The cushion has, moreover, only (0.170 m.) $\frac{55}{100}$ of a foot mean thickness in the direction of the length of the ajutage, and when the lift of the sluice-gate reaches, or exceeds, (0.150 m.) $\frac{49}{100}$ of a foot, we see that this ajutage approaches, in advantage, to those which have contraction at the entrance, or of the orifices with contraction on the upper side solely.

The change of direction that the water suffers in descending the

vertical pipe, to issue parallel to the bottom, occasions also a loss of active force, which ought to increase with the lift of the sluice-gate.

All these circumstances which concur to the same results, sufficiently explain, I think, the gradual diminution of the coefficients, and, as we have seen before, that this number, on the contrary, augments with the velocity of rotation, and that these two variations in opposite directions, depend upon the proportions of the wheel, we see that, in all experiments, or observations, on wheels of this species, it is indispensable to establish, for gauging the water expended, a stop-gate *above*, or better yet, *below* the wheel. It will be, moreover, always preferable to establish it below, because, on the one hand, the variations of level occasion much less error, and above all, less loss of time in regulating the level, and which we are able to appreciate, as we had to take at Müllbach, the volumes of water produced by the leakage, more or less great, of the reservoirs, and of the sluices.

We ought to remark that the experiments on the turbine of Moussay, have also shown that the coefficient of the discharge, diminished in proportion as the lift of the sluice-gate augmented, but that the increase produced by the centrifugal force, during the great velocities, did not there manifest itself in a notable manner; owing, perhaps, to this, that the wheel, having only a very little breadth, the action of this force there was much less sensible.

## XXVIII.

### *Experiments on the Turbine established in the Mill of Lepine, Canton of Arpajon.*

The account rendered of the session of the (French) Academy of Sciences of the 5th February, 1838, contains a series of experiments made by M. Dieu, Chief of Squadron of Artillery, and Inspector of the Gunpowder Manufactory of the Bouchet. We, from it, insert the results:

The gauge of the expense of water was made by means of a stop-gate placed *above* the wheel in the canal of supply, and forming a waste-board; and we have calculated the volume of water emitted by the formula,

$$Q = 0.406\ LH\sqrt{2gH}.$$

Floats placed above this waste-board, and above and below the turbine, served to measure the charge of water on the sill of the waste-board, and the total fall.

The *brake* was formed of a cast-iron muff, or collar, embraced by two pieces of wood which were placed on the shaft of the wheel, and continually wetted by a fillet of water which prevented the overheating of the surfaces, and kept them at a constant state of humidity. The other dispositions were also entirely analogous to those which we have before detailed.

The arm of the lever of the brake was (4 metres) $13\frac{12}{100}$ feet long, and the constant load was (0.625 kilogrammes) $1\frac{38}{100}$ pounds.

The results of the experiments are recorded in the following tables:

*Experiments on the Turbine of Lepine, near Arpajon, (Department of Seine-et-Oise.)*

| Nos. of the experiments. | Volume of water discharged in a second. | Total fall. | Theoret. Power of the motor. | | Total load of the brake. | No. of turns of the wheel in a minute. | Useful effect measured by the brake. | | Ratio of the useful effect to the theoretical power of the motor. |
|---|---|---|---|---|---|---|---|---|---|
| | | | No. kilog. lifted one metre per second. | No. horses-power. | | | No. of kilogs. lifted one metre in a second. | No. of horses-power. | |
| | M. cub. | Mtrs. | Kilog. | Hrs. pr. | Kilog. | No. | Kilog. | Hrs. pr. | |
| 1 | 0.436 | 2.073 | 904.0 | 12.05 | 22.625 | 73.77 | 699.0 | 9.32 | 0.773 |
| 2 | 0.440 | 2.048 | 901.6 | 12.01 | 18.625 | 88.20 | 688.2 | 9.17 | 0.763 |
| 3 | 0.440 | 2.065 | 908.6 | 12.11 | 20.625 | 80.35 | 694.0 | 9.25 | 0.763 |
| 4 | 0.440 | 2.065 | 908.6 | 12.11 | 22.625 | 72.58 | 687.7 | 9.17 | 0.757 |
| 5 | 0.440 | 2.048 | 901.0 | 12.01 | 24.625 | 67.16 | 692.7 | 9.23 | 0.768 |
| 6 | 0.440 | 2.043 | 898.9 | 11.98 | 26.625 | 64.10 | 714.8 | 9.53 | 0.795 |
| 7 | 0.436 | 2.048 | 892.9 | 11.90 | 28.625 | 58.44 | 700.6 | 9.34 | 0.784 |
| 8 | 0.436 | 1.993 | 868.9 | 11.59 | 17.625 | 90.90 | 671.0 | 8.94 | 0.772 |
| | 3.508 | 16.383 | 7184.5 | 95.76 | 182.000 | 595.50 | 5448.0 | 73.95 | 6.175 |
| Means. | 0.438 | 2.048 | 898.0 | 11.97 | 22.75 | 74.44 | 681.0 | 9.24 | 0.772 |

The examination of this table shows that this turbine, of which the fall at the time of making these experiments, was about (2 metres) $6\frac{56}{100}$ feet, realized a net useful effect equal to 0.772 of the theoretical power expended by the motor.

## XXIX.

### *General Summary of the Experiments on the Useful Effect of Turbines.*

From the whole of the experiments contained in this memoir, and of those which had before been made relative—

*To the Turbine of Moussay*, where the height of the fall has been, during the experiments, about (7.50 m.) $24\frac{61}{100}$ feet, and where the wheel has been immersed under water about (0.974 m.) $3\frac{19}{100}$ feet.

*To the Turbine of Müllbach*, where the height of the fall has been, during the experiments, about (3.50 m.) $11\frac{48}{100}$ feet, and which has been immersed under water about (0.750 m.) $2\frac{46}{100}$ feet.

*To the Turbine of Lepine*, where the height of the fall is (2 m.) $6\frac{56}{100}$ feet.

*To the Turbine of Inval*,* where the height of the available fall has been successively reduced from (1.174 m. to 0.293 m.) $3\frac{85}{100}$ feet to $\frac{96}{100}$ of a foot, whilst, on the contrary, the depth to which the wheel was immersed, has been augmented from (1.15 m. to 1.74 m.) $3\frac{77}{100}$ feet to $5\frac{71}{100}$ feet.

* See the Compte Rendus des Seances de l'Academie des Sciences, No. 9, 27th February, 1837.

Finally, from results obtained at the spinning factory at St. Blaise, in the Black Forest, where they used a fall of (108 m.) $354\frac{35}{100}$ feet! *with a turbine of* (0.55 m.) $1\frac{30}{100}$ *feet diameter, making* 2300 *turns in a minute! and transmitting a power of* 40 *horses!*

We are able to conclude:—

1. *That these wheels are equally suitable to the greatest, as to the smallest, falls.*

2. *That they transmit a net useful effect equal to* 0.70, *or* 0.78, *of the theoretical power expended by the motor.*

3. *That they are able to move at velocities extremely distant, more or less, from that which belongs to the maximum effect, without the useful effect differing notably from this maximum.*

4. *That they are able to do duty under water at depths from* (1 *to* 2*m.*) $3\frac{28}{100}$ *to* $6\frac{56}{100}$ *feet, without the ratio of the useful effect to the theoretical power of the motor, diminishing notably.*

5. *That as a consequence of the preceding property, they use all the time the whole available fall, since we place them below the level of the lowest waters.*

6. *That they are able to receive very variable quantities of water without the ratio of effect to power expended, diminishing notably.*

If we unite to these valuable mechanical properties, the advantage that they offer of occupying but little space, of being able, without any great expense, and without embarrassment, to be established in such part of the works as we wish, of moving generally at velocities much superior to those of other wheels, thus avoiding recourse to the transmission of complicated motions, *we conclude (without doubt with us) that these wheels ought to take rank amongst the best hydraulic motors.*

---

*Experiments on the useful effect of Turbines in the United States.*
By Ellwood Morris, Civil Engineer.

The above series of experiments on turbines, made by Morin, corroborated by other experimenters, and finally sanctioned by the approbation of the Academy of France—after undergoing the scrutiny of a special committee of their body deputed for that purpose—are beyond the reach of cavil, and must carry a conviction of the value of these hydraulic motors home to the minds of all who are capable of appreciating subjects of this nature.

Nevertheless, when the writer, some time ago, formed the resolution to attempt the introduction of these valuable water-wheels into use in our country, and entered into a business arrangement with Merrick & Towne, the well known machinists of Philadelphia, for that purpose, they were met at the threshold of their enterprize by an unusual degree of scepticism, which, unfortunately, received here, as in France, a slender resting point from the abortive efforts to construct successful turbines, which were made by some not sufficiently acquainted with the principles of these motors, whose attention had

been drawn to them by the articles upon turbines, published, by the writer, in this journal, during the autumn of last year.

It consequence, it seemed in some degree, incumbent on the writer, who had publicly declared the value of these motors, to demonstrate the apparent truism, that with properly constructed turbines, acting under a given quantity and fall of water, the economical results are the same in America as in France.

With this object in view, the writer has carefully tested the only two turbines made by Merrick & Towne, from his drawings, which have yet been put in action.

The first of these was set to work upon the 1st of January, 1843, at the Rockland Cotton Mills, upon the Brandywine stream, and has been running ever since with perfect success, and to the entire satisfaction of the proprietors.

It has continued to run, and drive the cotton mill at full speed, when the fall was reduced one-half by backwater, and when a large breast water-wheel, actuated by the same head race, was unable to turn for days together.

The experiments made upon this turbine, in the presence, and with the aid of the Messrs. Young, of Rockland, were communicated, by the writer, to the American Philosophical Society, on the 30th of May last, at the celebration of their hundredth anniversary, and will be found recorded in their published proceedings, whence the following is extracted:

"The experiments made in France, with the brake of M. Prony, have established, that the coefficient of effect of turbines, or the ratio of power actually realized, to that expended, *is, at an average, seventy per cent.* Mr. Morris has recently tested this result at the Rockland Mills, in Delaware, where the turbine is employed to drive a cotton mill: his experiments are collated in the table which closes this abstract.

"From these tabulated experiments it will appear that with lifts of sluice-gate, ranging from 5 to 7 inches, or from $\frac{5}{8}$ to $\frac{7}{8}$ of the full height of the turbine, and with velocities, at the inner circle, varying from about $\frac{9}{10}$ to near $\frac{5}{10}$ of the theoretical velocity, due to the working fall of water, this motor realized an useful effect, varying from 64 to 70 per cent. of the absolute power expended, or of that which is theoretically due to the expenditure of water, and the available fall at the time.

"The maximum effect seems to have been derived when the lift of the sluice-gate equalled 6 inches, or two-thirds, of the full height of the wheel; and when the turbine, at its inner circle, ran at a speed equivalent to 46 per cent. of the theoretical velocity of the water, issuing, under a head, equal to the working fall.

"An examination of the experiments from the 6th to the 14th inclusive, will show that the coefficients of effect within these limits, notwithstanding considerable variations in the relative velocities of the wheel, and its impelling water, averaged 67 per cent.; thus showing that this turbine, when run with a strong lift of sluice-gate, realized

as high a coefficient of effect, as was assigned by Smeaton to overshot water-wheels.

"With regard to the following table, Mr. M. remarked that the quantity of water used, which fixes the theoretical power due to the expenditure and descent, was determined by applying to the openings of the directing sluices certain coefficients of discharge, deduced from those of Morin, on the turbine of Müllbach, by a comparison of the velocities and lifts of gate in the one, and the other case: the results, therefore, are merely proximative, but cannot be very distant from the truth.

"The total fall of water at the Rockland Mills is usually about 7 feet; but the turbine has continued to drive the machinery of the mill effectively when the difference of level was reduced by backwater to three feet three inches, and the wheel was entirely submerged to the depth of four feet. With an external diameter of $4\frac{2}{3}$ feet, and a vertical thickness of about 8 inches, it propels the same machinery which heretofore required two breast wheels, one of 14 feet bucket, and 10 feet diameter, the other of 8 feet bucket, and 16 feet diameter, and uses one-third less water than the latter of these alone.

"Mr. Morris next adverted to the durability of the turbine; he supposes it less liable to wear at the pivot than the common water-wheel; as the latter while running supports a heavy load of water, from which the turbine is relieved by the interior fixed disc, which carries the directing sluices. In the turbine at Rockland, the pivot is ingeniously lubricated with oil by a syphon wick, the oil passing through an opening in the centre of the vertical shaft; after five months' use, the wear of the pivot is not perceptible." *

* At the time these pages are passing through the press, this turbine has been running eleven months, and no indications of wear are yet displayed by the pivot. We may, therefore, conclude, that no apprehensions need be entertained concerning the wear of the pivots of such turbines as are lubricated in this manner.

*Experiments upon the Turbine at the Rockland Mills, near Wilmington, Del., made by Ellwood Morris, C. E., January 21st, 1843.*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of the experiments. | Vertical lift of the annular sluice-gate in inches. | Aggregate area of the fixed disc open'gs exposed by the sluice-gate in sup. feet. | Proximate coefficients of discharge of the fixed disc openings. | Depression of the water surface in the head and tail races below a fixed level. | | Working fall during the experiments. | Theoretical velocity of water due to the working fall in feet per second. | Proximate quantity of water discharged by the Turbine in cubic feet per minute. | Theoretical power in horses power of 33,000 lbs. lifted one foot high per minute. | Useful effect produced by the turbine as actually measured by the brake dynamometer of M. De Prony. | | | Ratio of the speed of the wheel at the inner circle, to the theoretical velocity of the water due the working fall. | Approximate coefficient of effect, or ratio, of the power actually realized, to the theoretical power. |
| | | | | In head race. | In tail race. | | | | | No. of turns of the wheel per minute. | Load of brake at the end of a radius of 11 feet. | Horses' power developed of 33,000 lbs. lifted 1 foot high per min. | | |
| 1 | 1 | 0.344 | .930 | 3.083 | 9,937 | 6.854 | 20.9 | 401 | 5.2 | 38 | 14 | 1.1 | .317 | .211 |
| 2 | 2 | 0.687 | .923 | 3.083 | 9.625 | 6.542 | 20.5 | 779 | 9.6 | 58 | 28 | 3.4 | .500 | .354 |
| 3 | 3 | 1.031 | .918 | 3.125 | 9.479 | 6.354 | 20.2 | 1146 | 13.8 | 72 | 42 | 6.3 | .621 | .456 |
| 4 | 4 | 1.375 | .830 | 3.188 | 9.271 | 6.083 | 19.8 | 1355 | 15.2 | 74 | 56 | 8.6 | .652 | .566 |
| 5 | 4 | 1.375 | | | | | | | | 59 | 70 | 8.6 | | |
| 6 | 5 | 1.719 | .724 | 3.125 | 9.187 | 6.062 | 19.7 | 1471 | 17 | 57 | 98 | 11.7 | .505 | .688 |
| 7 | 5 | 1.719 | .742 | 3.125 | 9.187 | 6.062 | 19.7 | 1507 | 17.3 | 67 | 74 | 11.8 | .593 | .682 |
| 8 | 6 | 2.062 | .720 | 3.229 | 9.208 | 5 979 | 19.6 | 1745 | 19.8 | 64 | 98 | 13.1 | .565 | .662 |
| 9 | 6 | 2.062 | .720 | 3.229 | 9.208 | 5.979 | 19.6 | 1745 | 19.8 | 59 | 108 | 13.3 | .525 | .672 |
| 10 | 6 | 2.062 | .700 | 3.188 | 9.125 | 5.937 | 19.5 | 1688 | 19 | 46 | 136 | 13.1 | .411 | .690 |
| 11 | 6 | 2.062 | .700 | 3.188 | 9.125 | 5.937 | 19.5 | 1688 | 19 | 52 | 122 | 13.3 | .465 | .700 |
| 12 | 7 | 2.406 | .700 | 3.125 | 9.042 | 5.917 | 19.4 | 1960 | 22 | 49½ | 136 | 14.1 | .445 | .641 |
| 13 | 7 | 2.406 | .700 | 3.104 | 8.958 | 5.854 | 19.3 | 1950 | 21.6 | 56½ | 122 | 14.4 | .510 | .667 |
| 14 | 7 | 2.406 | .700 | 3.146 | 8.958 | 5.812 | 19.3 | 1950 | 21.1 | 60 | 115 | 14.4 | .542 | .683 |

Since these experiments were communicated to the Philosophical Society, the second turbine has been put in operation at the powder works of the Messrs. Dupont, in Delaware.

The writer availed himself here of the liberality and aid of Alfred Dupont, Esq., (whose extensive experience in the use of water power is well known,) to make a series of trials with this motor, in which the amount of water used by the turbine, inclusive of a small leakage from the fore-bay, was measured in two ways:—

1. By causing it to pass through the rectangular aperture of a common head-gate, under different heads.

2. By causing it to flow with a clear fall, over the edge of a waste-board notched 6 feet wide, and 9 inches deep, and placed in the tail-race, where it was 9 feet wide between the side walls.

The coefficients of discharge to be applied to the theoretical expenditure from the openings of rectangular gates and waste-boards, in order to determine the actual quantity of water passing in a given time, have been so fully settled by numerous experiments, that scarcely any more satisfactory mode of measurement could be devised.

In calculating the results of the following table, the formula used for the head-gate measurements is

$$* \quad Q = 0.625 \sqrt{2gH} \times A;$$

where Q = actual quantity of water passing per second in cubic feet.

$2g = 64\frac{1}{3}$ feet.

H = the head in feet under which the water issued through the opening exposed.

A = area of gate drawn in superficial feet.

This formula, to facilitate the calculations, is usually transformed into

$$Q = 5 \sqrt{H} \times A,$$

in which shape we have applied it.

In the four experiments, where the waste-board was employed as a meter of the quantity of water used, it so happened that the depth of the sill beneath the surface of the still water above, was almost exactly the same as the depth of the notch, *or* 9 *inches.*

Now, for this depth the coefficient of discharge has been shown by Poncelet, and Lesbros, from actual experiment, to be 0.385, and hence the formula for the expenditure by the waste-board would be

$$\dagger \quad Q = 0.385 \, LH \sqrt{2gH},$$

where Q = quantity of water discharged per second.

L = length of opening of waste-board.

H = depth of the sill, or edge, below the level of still water = 0.75 feet in this case.

$2g = 64\frac{1}{3}$ feet.

computed by this formula, the flow over the waste-board was 12 cubic feet per second.

* See Morin's "Aide Mémoire de Mechanique Pratique," edition of 1843, ps. 6 and 23.

† See Morin's "Aide Mémoire, p. 37.

But being desirous of enabling a closer comparison to be instituted between the experiments recorded in the following table, and those of Morin on the turbine of Müllbach, the writer has adopted, for the waste-board, the same formula that Morin used, viz.,

$$Q = 0.405\,LH\sqrt{2gH};$$

this formula gives a greater expenditure, and, of course, a lower coefficient of effect for the turbine than the former.

It will be borne in mind that in the following table the quantities of water used, actually include whatever leakage existed in the forebay, but as this did not seem to be very considerable, and as it was the wish of the writer not to undervalue the amount of water expended by this turbine, he did not think it worth while to measure and deduct the leakage referred to.

The turbine experimented upon, in this instance, has an exterior diameter of 4 feet 5 inches, its height is 6 inches, and throughout the experiments the lift of the sluice-gate was uniformly 4½ inches, or three-fourths of the full height.

With the view of ascertaining the statical force exerted by Dupont's turbine with 4½ inches gate drawn, weights were added in the scale, and the brake was screwed up, on two occasions, until the wheel stopped. It was then found that the standing power of this turbine, or the weight which it equilibrated, was 198 pounds at the end of a radius of 6 feet, when the fall was $4\frac{2}{10}$ feet, and 190 pounds under a fall of $4\frac{1}{10}$ feet.

These experiments offered also, to the eye, an excellent demonstration of the truth, that, when turbines run at their proper speed, the water drops from them *without velocity;* for when the wheel was stopped by the brake, the water rushing from the buckets with a velocity due to the fall, reacted violently from the walls of the tail-race, and produced a great commotion in the tail-water. But the moment the screws of the brake were relaxed, and the wheel had gained its proper speed, the tail-water became perfectly calm, and flowed away in a smooth, unbroken sheet; thus clearly showing that the water quitted the wheel without velocity, for otherwise it would have reacted from the walls, and disturbed the tail-water as before.

*Experiments made Oct. 3rd and 4th, 1843, by Alfred Dupont, Esq., and Ellwood Morris, C. E., upon the Turbine at the Powder Works, on the Brandywine, near Wilmington, Delaware.*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of the experiments. | Vertical lift of the head-gate drawn to admit water to the Turbine. | Width of the head-gate drawn. | Opening of the head-gate drawn. | Head under which the water issued through the openings of col. 4. | Quantity of water used per second, or that which passed to the turbine thro' the openings of head-gate drawn in column 4. | Working fall during the experiments. | Theoretical velocity of water due to the working fall per second. | Theoretical Power in horses-power of 33,000 pounds lifted one foot high per minute. | Useful effect produced by the Turbine, as actually measured by the brake dynamometer of M. de Prony. | | | Ratio of the speed of the wheel at the inner circle, to the theoretical velocity of the water due to the working fall. | Coefficient of effect, or ratio of the power actually realized, to the theoretical power of the water. |
| | | | | | | | | | Revolutions of the wheel per minute. | Load of the brake at the end of a radius of six feet. | Horses power developed of 33,000 lbs. lifted one foot high per minute. | | |
| | Inches. | Inches. | Sup. ft. | Feet. | Cub. feet. | Feet. | Feet. | H. pr. | Revolu. | Pounds. | Hrs. pr. | Ratio. | Coeffi. |
| 1 | Water measur'd by waste-board. | | | | 12.63 | 4.1 | 16.2 | 5.6 | 25. | 119. | 3.4 | .254 | .578 |
| 2 | 6. | 30.75 | 1.28 | 2.4 | 9.92 | 2.9 | 13.6 | 3.3 | 28. | 63. | 2. | .332 | .606 |
| 3 | 18. | " | 3.84 | 0.46 | 13.02 | 4.7 | 17.3 | 7. | 36. | 119. | 5. | .336 | .714 |
| 4 | Water measur'd by waste-board. | | | | 12.63 | 4.1 | 16.2 | 5.6 | 39. | 91. | 4. | .389 | .678 |
| 5 | 31. | 30.75 | 6.62 | 0.208 | 15.09 | 4.9 | 17.7 | 8.4 | 49. | 112. | 6.3 | .447 | .750 |
| 6 | 18. | " | 3.84 | 0.5 | 13.57 | 4.6 | 17.2 | 7.1 | 50. | 91. | 5.2 | .470 | .732 |
| 7 | 12. | " | 2.56 | 1. | 12.80 | 4.2 | 16.4 | 6.1 | 48. | 80. | 4.4 | .473 | .721 |
| 8 | Water measur'd by waste-board. | | | | 12.63 | 4.1 | 16.2 | 5.6 | 50. | 73. | 3.4 | .498 | .712 |
| 9 | 12 | 30.75 | 2.56 | 1.1 | 13.44 | 4.2 | 16.4 | 6.4 | 52. | 70. | 4.2 | .512 | .656 |
| 10 | 12 | " | 2.56 | 1.1 | 13.44 | 4. | 16. | 6.1 | 56. | 63. | 4. | .565 | .656 |
| 11 | Water measur'd by waste-board | | | | 12.63 | 4.1 | 16.2 | 5.6 | 57. | 63. | 4.1 | .569 | .695 |
| 12 | 16 | 30.75 | 1.28 | 2.6 | 10.24 | 2.7 | 13.1 | 3.1 | 50. | 35. | 2. | .614 | .645 |
| 13 | 12 | " | 2.56 | 1.1 | 13.44 | 4. | 16. | 6.1 | 62. | 49. | 3.5 | .625 | .574 |
| 14 | 12 | " | 2.56 | 1.1 | 13.44 | 4. | 16. | 6.1 | 65. | 42. | 3.1 | .656 | .508 |
| 15 | 12 | " | 2.56 | 1.1 | 13.44 | 4. | 16. | 6.1 | 70. | 85. | 2.8 | .770 | .459 |

*Observations on the above Table.*—In the 1st, 4th, 8th, and 11th experiments, the turbine was entirely submerged to a depth of 28 ins., and in all the rest its top ran 18 inches under water.

The experiments from 1 to 3 inclusive, show that even with velocities, at the inner circle, ranging so low as from 25 to 33 per cent. of

that due to the water by theory, the turbine realized, at an average, 63 per cent. of the full power of the water.

The experiments from 4 to 9 inclusive, show that when the turbine ran at a speed of from 40 to 50 per cent. of the theoretical velocity of the water (within which limits this wheel will always move,) it realized, at an average, about 71 per cent. of the theoretical power of the water; and the 5th experiment, which indicates the maximum effect, shows that when running with a speed of 45 per cent. of that of the issuing water, *its coefficient of effect reached seventy-five per cent.*

The experiments from 10 to 15 inclusive, show that with the high relative velocities of 50 to 70 per cent. of that of the issuing water, this turbine still retained an average useful effect of near 60 per cent.

The 12th experiment shows that even with a fall of but $2\frac{6}{10}$ feet, and though the wheel ran at too great a velocity, it still realized 64 per cent.

The above experiments, made with falls of water ranging from $2\frac{6}{10}$ up to $4\frac{9}{10}$ feet, and under a back-water equal to a third, or even a half, of the whole fall, corroborate those of Morin and others, upon these motors, and they prove, that whilst turbines possess a most singular power of adaptation to very different velocities without much loss of power, if their speed at the inner circle be confined within the limits of 40 to 50 per cent. of that due by theory to the issuing water, *we may safely calculate upon a useful effect of full seventy per cent.*

Before these pages issue from the press, there will be in operation *seven turbines*, constructed by Merrick & Towne, from the writer's drawings, to wit:—

One of 4 ft. 8 ins. diameter, driving a cotton mill at Rockland, on the Brandywine, in Delaware, with 6 ft. working fall.

One of 4 ft. 5 ins. diameter, driving a powder mill at Duponts, near Wilmington, Delaware, with 4 ft. working fall.

One of 4 ft. 8 ins. diameter, driving a woolen mill on the Crosswicks creek, New Jersey, with 7 ft. working fall.

One of 7 feet diameter, driving a heavy saw and plaster mill, on Millstone river, New Jersey, with 3 ft. working fall.

One of 6 ft. 6 ins. diameter, driving a woolen mill at Rokeby, on the Brandywine, Delaware, with 5 ft. working fall.

One of 3 ft. 2 ins. diameter, driving a grist mill on the Brandywine, near Coatesville, Pennsylvania, with 17 ft. working fall.

One of 6 ft. 6 ins. diameter, driving a large cotton mill at Phœnixville, Pennsylvania, with 8½ ft. working fall.

These turbines varying in power from 4 to 30 horses, applied to different uses, running under various falls of water, and all of them placed so as to be more or less submerged by back-water, will demonstrate their utility, to practical men, in a manner which cannot be mistaken.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Description of a Wrought-Iron Beacon erected at the harbor of Black Rock, in Long Island Sound, in the summer of* 1843. By W. H. SWIFT, Capt. Corps Topl. Engs.

We are indebted to the officer who erected this work, for the following description, which we have prefaced with a brief history, derived from authentic sources, of other structures erected in the same place, all of which have been, sooner or later, overthrown.

The vast magnitude and growing importance of the light-house establishment, and the large sum annually appropriated for repairs in this department of the general government, may render this brief history interesting.

The harbor of Black Rock lies about 18 miles westward of New Haven; it is accessible at extreme low water for vessels drawing 10 feet, and at high water it may be entered by vessels drawing from 16 to 18 feet. As a harbor of refuge it is more resorted to, perhaps, than any other in the sound, the depth of water being sufficient in all cases, for that class of vessels which are usually employed in the navigation of this great thoroughfare.

In 1829 a beacon of stone was built at this place under the orders of the Treasury Department, at a cost of about 6000 dollars. This beacon was entirely destroyed by a gale of wind in less than one month after it was erected. In the year 1835 it was rebuilt at an expense of nearly 9000 dollars: in the spring of 1836 it was injured by a gale of wind, so seriously that, in all probability, it would have been entirely demolished by the recurrence of the first heavy gale. It was then repaired with a guarantee from the contractor, that he would maintain the beacon in its position for a period of five years: this was effected at a cost to the United States of 6500 dollars. One year after the expiration of this guarantee, (in 1842) the beacon was again so much injured by a gale of wind, that the whole structure must have fallen, had not the long stones of which the upper part of the beacon was constructed, been held together in place by the wooden spar, or mast, which was used for supporting the cask; the stones were laid around this spar, and it served to prevent them from separating from each other. Thus, it will be seen, that within a period of 12 years, three stone beacons have been destroyed at this place, and that the cost to the United States has been upwards of 21,000 dollars.

In March, 1843, an appropriation of 10,000 dollars having been made by Congress, for rebuilding the Black Rock Beacon, the Secretary of the Treasury applied to the Secretary of War to allow this beacon to be constructed under the direction of the Chief Topographical Engineer, and by the orders of Colonel J. J. Abert, the work was entrusted to the superintendence of Captain W. H. Swift.

*Description of the work by Capt. Swift.*

The beacon stands one mile and a half south of the entrance to the

harbor, and is exposed to all winds from E.N.E.; around by the South to W.S.W.; from the East it is entirely open to the rake of the sea for a distance of sixty miles.

When the first beacon was built in 1829, a large quantity of pebble stone was carried in vessels to the proposed site, and there thrown into the water around a single rock called the "Old Huncher," and upon which there had been an iron spindle in former years; this rock was conical in shape, about 4 feet in diameter at top, and bare at very low water. Upon this loose stone, thus deposited, the superstructure was reared, and when the beacon was overthrown, the materials of which it was composed, were, of course, added to the rubble stone bed, and they, in turn, became the foundation for the beacon of 1835.

In the examination which I made of the site in June, preparatory to making the final plan for the iron work, I ascertained that the stone below low water, had, apparently, remained unmoved for a long time, and I subsequently found, by inquiring of Capt. Wilson, the contractor, who had repaired the beacon in 1836, and who had maintained it in repair for five years, that such was the fact; while, as he stated, and it was evidently true, the stones between low and high water were thrown about by the force of the sea in every gale. This was fully exemplified too by the appearance which the injured part of the old beacon presented; the base, or that part below low water was entirely undisturbed, the breach being between high and low water marks; all the stone below low water remaining, as stated by Capt. Wilson, as they were when the beacon was repaired in 1835.

There being no stone of sufficient size at the old beacon into which the iron shafts of the new structure could be secured, I found it necessary to procure elsewhere such as were suitable for the purpose, and to transport them to the site, and imbed them below the line of low water, in order that the sea might not disturb them after they should be laid.

*Description of the stone foundation.*

The beacon, according to the general plan which I had made, and submitted to Col. Abert on the 30th of April last, was to be elevated 36 feet, and for this height I decided to give the iron shafts a spread, or base, of 16 feet, with an inclination towards the centre of about 1 to 6. In order that there should be sufficient strength in the stone to resist any tendency there might be to fracture at the holes which were to receive the feet of the shafts, I adopted the dimension of 20 feet as a suitable diameter for the stone bed designed for the shafts to be secured to; this dimension gave a distance of about 2½ feet from the centre of the shaft holes to the edge of the stone at top, while at the bottom of the stone, where the strain is less, it would be 2 feet. The bed then is composed of 6 pieces of hammered granite, 2½ feet thick; the middle stone is round, and is 8 feet in diameter, the five outer stones are 6 feet wide by about 12 feet in length, each stone weighing nearly 12 tons; the stone are cramped and doweled together with 1½ inch round copper, two at each joint, the cramps 2 feet long, and the dowells 10 and 12 inches long.

The excavation which was made in what may be called the artificial island (for at low water an extent of 105 ft. from east to west, and 88 ft. from north to south is exposed,) for the reception of the stone bed is a few feet N.W. from the old beacon, it was 26 feet in diameter, and 3 ft. below *ordinary* low water. When the excavation was completed, a layer of concrete, composed of 5 parts of hydraulic lime, to 8 parts of sand, was spread over the bottom of the pit by means of a trough of wood for the foundation stone to rest upon. After the stones were laid, which was effected by means of a heavy pair of shears, and a "Lewis," the unoccupied space in the pit around the outside of the stone bed, was filled with concrete and rubble stone flush with the top of the foundation stone. As it was only at, or near, low water that this part of the work could be carried on, that is to say ordinarily, about three hours per day in good weather, considerable time was necessarily consumed in getting in the foundation; from the day the shears were erected to the day the stone work was completed, was just five weeks.

*Description of the Iron work.*

The figure of the beacon is that of a truncated pyramid; it is formed of six wrought-iron shafts, five of them 36 ft. 7 ins. in length, standing in the periphery of a circle of 16 ft. diameter, and one 36 ft. long at the centre, the outer shafts incline towards the middle in such proportion, as to fall at the top within the circumference of a circle of 3 ft. diameter; each of these shafts is composed of two pieces of equal length, the diameter at the foot of the lower piece is 5¼ ins., and at the top 4 inches; the diameter of the upper piece is 4 ins. at the foot, and 3 ins. at the top, they are united by a cast-iron socket of 3 ft. in length, 2½ ins. thick at the joint of the shafts, which is at the middle of the socket, 2 ins. thick at the top and bottom, and 1 inch thick elsewhere; the top of the lower shaft is made concave, and the bottom of the upper shaft convex, fitting one into the other. At the distance of one foot from the joint of the shafts, a steel key 2 inches deep by ¾ of an inch wide, passes through the socket and each shaft to secure them together; the sockets inside, and 18 ins. of the ends of the shafts are turned and accurately fitted to each other. At a distance of 2½ feet from the foot of the lower shafts, are 4 shoulders one foot long, and projecting, at the lower extremity, one inch from the shaft to form points of support for the same at the surface of the foundation stone. Above and below the joints of the shafts, and at distances of 9 ft. and 18 ft. respectively above the top of the stone, are two sets of braces extending from the middle shaft to each outer shaft, and from one outer shaft to another, making ten in each set; the braces are of wrought-iron 2½ ins. square, the extremities are secured by 1¼ inch screw bolts to cast-iron collars, these collars are strengthened by two wrought-iron bands, and are firmly attached to the shafts by steel keys; the space between the collar and shaft, and between the keys is filled with zinc; the braces are secured to the collars in such a manner that they serve for ties in case of any unforseen strain acting

from the *interior* of the beacon, such as might possibly be occasioned by ice, or any other floating body.

The top of the shafts are provided with shoulders to support a cast-iron cap, composed of five arms, each 3 ft. in length, and 4 ins. in width, strengthened by a rib, or flanch, of 3½ ins. in depth; the shafts pass through this cap 18 inches from the centre of it, and are there keyed in place; a wrought-iron band 3 ins. wide, and ½ inch thick, is shrunk upon the extremity of these arms to add to its strength; from the ends of the arms of the cap, 3 ft. from the centre, braces of 2 ins. round iron descend 4½ ft. to the main shafts, and are there secured by screw bolts passing through their extremities, and through the shafts also. At this junction of the braces with the shafts, a wrought-iron band, similar to that which encircles the cast-iron cap, is fitted and bolted at a distance of 4½ ft.; again below this second band is a third band similar to the two others, and similarly secured by screw bolts through the shafts; finally, there are 10 panels, or gratings, 4½ feet long, corresponding in shape and dimension with the wrought-iron bands between the shafts, and the wrought-iron bands; these gratings are made of boiler iron $\frac{3}{16}$th of an inch thick, with eight horizontal and 3 vertical slats, or bars, 3 ins. wide, riveted together; the horizontal slats are 3 ins. apart, but at the distance of 500 yards, the top of the beacon presents the appearance of an opaque body 9½ ft. long by 6 ft. wide at the top and bottom, and 4½ ft. wide midway of the same.

The feet of the iron shafts penetrate the stone foundation 2½ ft., and are secured in their places by heavy iron wedges fitted to the unoccupied spaces between the sides of the holes in the stone and the shafts; the holes being inclined, and the braces between the shafts being immovable. It is evident that the feet cannot be withdrawn from their places without rupture. Now, the braces are of 2½ inch square iron, and the thickness of the stone outside of the hole is 2½ feet, and this would seem to present sufficient strength to resist a shock from any ordinary cause.

In addition to the concrete around the outside of the stone, and the cramps and dowells to secure the same together, there are nve iron ties of 1½ ins. diameter, extending from a collar of two inch wrought iron, which surrounds the middle shaft, to each of the outer shafts to which they are firmly and securely attached by means of heavy iron stirrups; the ends of the ties are furnished with screws and nuts, and by this means can be kept in a constant state of tension. This arrangement was resorted to as an additional means of preventing any tendency there might be in the outer foundation stones to separate themselves from the middle stone.

The beacon, as finished, stands 34 ft. above low water, and 3 ft. higher than the old beacon; the cage, or grating, is painted black, and the shafts vermilion red.

A model of the work upon a scale of one inch to a foot will be deposited in the Bureau: this, with the accompanying plan in detail, will convey all the information in reference to the construction which may be required.

The iron work was executed in Boston by Messrs. Cyrus Alger & Co., under the immediate superintendence of Mr. Lester; the entire weight is upwards of 19,000 lbs. The foundation was prepared, and the beacon erected in place by Mr. Benjamin Pomeroy, of Stonington, Ct., under a contract made with him for that purpose. The entire cost of the iron work and foundation was about 4600 dollars, and the time consumed in the construction was three months.

I had it in contemplation at one time to coat the iron work with zinc, by means of electro-galvanism, but I found that too much time would be required for preparing the necessary tanks and apparatus. I venture to hope, however, that another occasion may present itself, and that in the more important structure of the "screw pile light," which, I trust, I shall one day see executed upon our own shores, that the galvanizing process may be successfully applied.

In conclusion I beg to call attention to one or two of the more important advantages which this application of one of the principles of Mitchell's Screw-pile, to the construction of light-houses and beacons, presents.

In a very exposed situation, a light, or a beacon, if built of masonry, can only stand when the best description of work is introduced; this, of course, involves great expense, and much time. The mode of construction for such situations must, in principle, be similar to that adopted for the Eddystone and Bell Rock lights, and this, as all know who understand the subject, would, in the case of our own coast, present *an insuperable objection;* for example, the Bell Rock Light, on the coast of Scotland, cost £360,000, or 1,800,000 dollars, and four years were required to build it, this too in a situation where the rock upon which it is placed is bare at low water. The Eddystone was neither so costly, nor did it require so much time to complete it, still $ would, with us, justly be considered out of the question for a single light.* There are many places upon our coast at which the screw pile light could be erected at a very moderate cost, far less, indeed, than that of a light ship; notwithstanding this there are at this time not less than floating lights in Pamlico Sound, on the coast of North Carolina. The Middle Ground, in Long Island Sound, upon which there are only 3 feet at low water, and at which a light boat is now maintained, is, of all others, the most suitable point to make the first experiment upon with this description of light.

In reference to the durability of wrought-iron exposed to the action of sea water, I have not a great deal of information to impart, still I have some which bears upon this question. Upon many of the reefs in Long Island Sound, and more particularly in Fisher's Island Sound, it has been the practice for many years to erect wrought-iron spindles of about 4 inches diameter, and from 15 to 25 feet in height; such spindles last from 15 to 20 years, unless carried away by ice. The contractor who placed several of these spindles, informed me that

* The Car Rock Beacon, on the coast of Scotland, cost 25,000 dollars; six years were required for the construction; it was intended to build it entirely of stone, but when half finished the upper part was constructed of cast-iron. The cast-iron beacon on York Ledge Maine, is an exact copy of the Car Rock Beacon: it cost 10,000 dollars.

one upon a reef in Fisher's Island Sound had been up 20 years without being renewed; the wasting takes place principally between high and low water, and in this particular case, the size of the spindle is reduced from 4 to 2 inches in diameter. If, however, the zincing process, or if a precipitate of copper, be resorted to, there is every reason for believing that the iron thus protected would last twice, or three times, 20 years. In short, economy in cost and in time, and the application of the principle of the screw pile in situations where masonry could not be resorted to without inordinate expense, would seem to be advantages in themselves sufficient to justify extensive experiments in a branch of the public service of such importance as that of our light-house system.

---

## *Mr. Vignoles' Lectures on Civil Engineering, at the London University College.*

(Continued from page 306.)

### Lecture xvi.—Working Expenses of Railways—*(Continued.)*

The result of the examination into the expense of passenger traffic had been investigated in the last two lectures, and a general average cost had been deduced, varying from two-thirds of a penny to one penny per mile per passenger, including the Government duty, the fraction varying, of course, with the number of passengers in the train. It would not be necessary to go as minutely into the items of corresponding expense of merchandize and mineral traffic, nor would this last lecture but one of the course allow sufficient time to do so. Mr. Vignoles said he should endeavor to compress what he had to explain further about railway expenses into this evening's address, and, in the concluding lecture, he would take a general review of the whole of his course on railway matters. The cost of carrying coals, at very moderate velocities, on the great colliery railways, is about one penny per ton per mile, which may be divided into the following heads, viz:—

*Expense of Transport of Coal.*

| | Dec. of a penny. |
|---|---|
| Locomotive power, - - - | .38 |
| Wagons, - - - - | .19 |
| Conducting traffic, - - - | .08 |
| Maintenance of railway, - - | .21 |
| General expenses, including local taxes, | .14 |
| Per ton of coal per mile, - | 1.00 |

The proportion of the weight of the coal to the gross load carried being as 3 to 5. The expense of carrying goods on the Liverpool and Manchester Railway, taken on the average of seven years' traffic, appears to be about 2½d. per ton per mile, divided as follows:—

*Expense of Transport of Merchandize.*

| | Dec. of a penny. |
|---|---|
| Locomotive power, - - - - | .57 |
| Wagons, - - - - - | .23 |
| Conducting traffic, - - - - | 1.08 |
| Maintenance of railway, - - | .31 |
| General expenses, including local taxes, | .35 |
| Per ton of goods per mile, - | 2.54 |

But in this sum is included a considerable item, which does not properly belong to the railway itself, viz., the cost of collecting and delivering the goods all over the towns at the two termini, by carts and wagons, and full ½d. per ton may be taken off for this item—making the total expense 2d. per ton per mile—the proportion of useful weight, of weight of merchandize carried, to the gross weight, including the wagons, being as 1 to 2. We have now the results of many years' working expenses of railways for passengers, as we have investigated in the two last lectures, and, as above, for coal and merchandize, which may be tabulated thus:—

*Expense of Railway Transport per mile.*

| | |
|---|---|
| Passengers, at high velocities, - - - | 1d. each. |
| Coal, at very moderate speed, - - - | 1d. per ton. |
| Merchandize, at fifteen miles an hour, - - | 2d. " |

Reducing the expenses of passenger traffic to a tonnage—taking the weight of twelve passengers and their luggage as being, on the average, equivalent to a ton—we obtain 1s. per ton per mile, which is twelve times the expense of carrying coal, and six times that of conveying goods. A portion of this difference, but not all, is due to the velocity, for, though it would seem that this doubles the cost of goods, as compared with coals, it is not so in fact, as a large proportion of expense is incurred in the handling and office work necessary for merchandize traffic, to which coal is not liable. Comparing the proportion, between the useful, or paying, load, and the gross weight moved, including the vehicles, we have, coal 3 to 5, merchandize 1 to 2, and, as explained in the preceding lectures, passengers 1 to 6, and often more. The consideration of the comparative view in this light led Mr. Vignoles to observe, that, notwithstanding the apparent difference, there is a great analogy between the proportion, as regards goods and passengers, for, if the passenger trains could be fully loaded, the proportion between the profitable, and the gross, load, would be nearly the same, both for passengers and merchandize, the result being almost similar, as regards the actual weight to be transported, and the preparation to be made for moving the mass—at the same time, it was an additional and collateral proof that the figures laid down in the above general terms, by the Professor, might be depended upon. On colliery and mineral railways the traffic is arranged so as to carry the *maximum* profitable load on a *minimum* weight of vehicle; supposing coal and merchandize were really conveyed on equal terms in every thing except speed, the difference in velocity would appear

to effect a saving of one-half. This, however, is not the case; the difference of expense due to velocity, may, perhaps, be stated at from .50 to .60 of a penny per ton per mile as a *maximum*; the remainder of the difference is chargeable to the mode of conducting the traffic; and, in reference to the passenger trains, it should be borne in mind, that it is the necessity of meeting the fluctuation of passenger traffic, and, in order that the public may be accommodated, that, taking weight for weight, it costs railway companies six times as much to convey passengers as to transport goods. On the other hand, ten years' experience of the working of the Liverpool and Manchester Railway produces the result that their profit upon the conveyance of a single passenger averages the same as the profit on the carriage of a ton of merchandize. But why? On that line, there being a great competition with the river and canal navigation, the rate of charges for goods has been brought down to the lowest terms, for the utmost possible extent of accommodation of warehousing, delivery, &c.; but there being a practical monopoly in the conveyance of passengers, the fares are not quite to a *maximum*, but still very high. Mr. Vignoles observed, in applying these facts, that it had been one of the objects of these lectures to show, and he wished to enforce it on the minds of the class, as a useful and easily attainable result, that, by sending trains more frequently, with fewer carriages, and by constructing those carriages to a better proportion between the paying and the unprofitable load, the increased accommodation would bring increased traffic; for, considering that the expense of transport is but little affected by the number of passengers, by such increase the expenses, as computed per passenger per mile, might be fairly calculated as susceptible of being reduced from 1d. to ½d.; supposing every other condition to be as at present: another advantageous consequence would be that of keeping the engines above their work. Such an arrangement of trains bore greatly upon the important question of what amount of extra expenditure on railways could be fully justified by prospectively consequent beneficial results; but the Professor said he would not again enter into the question of gradients. The necessity of perfect gradients assumed *maximum* loads as generally occurring, whereas exactly the opposite was the case in practice, especially with passenger trains, and on lines in districts not adjacent to the metropolis, or our largest commercial and manufacturing towns; indeed, it is remarkable how nearly alike in all railways, whose gradients differed greatly, were the working expenses per train per mile. On the North Union Railway, for example, where five miles out of twenty-two are at an inclination of fifty-three feet per mile, the mileage expenses of working trains is quite as small as upon railways of which the gradients are nearly horizontal; and it was found that up to six or eight carriages, or from that number even up to ten vehicles per train, no very material mileage difference of working expenses results on lines with what are called comparatively favorable, or unfavorable, gradients. Mr. Vignoles then referred to a former lecture, wherein he had considered how far beyond 10,000*l.* per mile, as the total cost of any given line of railway, it was justifiable to incur increased ex-

pense in the formation, to obtain more perfect gradients, or to make the railway at all. He observed that the late Irish Railway Commissioners had distinctly shown by a different process of reasoning, and on different data, that any excess above this sum could seldom be advisable in agricultural countries, or where the traffic was inconsiderable, and the Professor strongly insisted that it was more expedient to encounter inclinations of fifty, sixty, or even eighty, feet per mile, with lighter trains, or heavier engines, and at a somewhat greater cost of working per mile, than to incur the expense of vast excavations and embankments, and costly works of art, to obtain better gradients. He particularly referred to his own practice in this respect, and to his report to the above commissioners on the laying out of the railways in Ireland, and observed that the French engineers had fallen into a great mistake in proposing such expensive sections for the French lines. On the Liverpool and Manchester Railway, and, indeed, on several other lines, the expense of locomotive power was only about one-fourth of the whole cost of transport; but, supposing it to be as much as one-third, it would be found that not a third part of this third, or not more than one-ninth part of the whole working expense, was effected by the gradients, and nearly all other expenses, beyond increased fuel and repairs, on account of steep inclinations, were common to all lines, and depended upon management rather than the gradients. If the number of miles run by engines with trains, and the total annual cost of working various railways, were taken, and also the corresponding amount of gross receipts and net returns per train per mile, and a comparison made with the interest of the capital expended, it would be found that on very few lines, indeed, had the vast expense of obtaining good gradients been justified. Mr. Vignoles observed that, having determined the cost of conveying goods and passengers, as before explained, and having ascertained the probable amount of traffic, it would be found that the public could seldom afford to pay higher charges than such as, in addition to the cost to the company, would leave them a profit per passenger per mile of 1d.; per ton of goods per mile of 1d.; per ton of coals per mile of ½d. On the continent the people could not give half the above, and so in Scotland and in Ireland; any increase driving the traffic into other channels, as in the case of the Paisley and Greenock Railway, or, perhaps, stopping it altogether. On the great traveling lines monopoly entirely kept up higher prices, but intercourse was thereby greatly impeded, and the public suffered, and the traffic returns published, showed that the limits of receipts had been attained on many of them. On the Dublin and Kingstown Railway the average expense of conveying passengers was only ½d. per mile, and the profit to the company a trifle above that figure—say, about five-eighths of a penny per passenger per mile; this low fare produced a steady and regular increase of intercourse. The profit to the great English railway companies was about 2d. per passenger per mile, which was, perhaps, often not more than what was requisite to pay for the great, and, as the Professor argued, the useless, increased expense of these principal lines, but the traveling public paid dearly for

it. Mr. Vignoles observed, in conclusion, that, what he had stated were sure and simple data by which the working of the existing and future railways might be dissected, and a judgment formed on how far it was advisable to have spent 250,000*l.* per mile on the Greenwich and Blackwall Railways, and an average of 50,000*l.* per mile for many lines whose prospects could never have justified it, particularly if *à priori* investigations, such as those here gone into, had been instituted.

To be Continued.

---

## Franklin Institute.

*Address of* JOHN WIEGAND, ESQ., *Chairman of the Committee on Exhibitions, preceding the reading of the Report of the Committee.*

*Ladies and Gentlemen,*—In conformity with our arrangements, we meet you this afternoon for the purpose of presenting our report on the Exhibition of American Manufactures, which is now before you, and of distributing the Premiums, and other honorary distinctions which we have had the pleasure to award. It is with no ordinary gratification that we perform this duty. Before proceeding to discharge it, we feel that our warm congratulations should be exchanged upon the triumphs of American industry, which are spread out in such rich variety and excellence in these spacious halls. Compared with the first exhibition of the kind held by the Institute, in the year 1824, how great have been the improvements, and how wonderful the changes we witness. We remember how limited in variety, and how imperfect in finish, were the specimens then exhibited.

It is but a few, a very few, years since, that the hope was, in any degree, entertained that we might be able, as a nation, to supply our own domestic wants.

A few short years, and we have even more than realized our most sanguine desires: we now stand forth competitors with the great manufacturing nations of the world. All this, too, has been accomplished in a period of time so short, when compared with the rise and progress of manufactures in Europe, that we can scarcely believe the evidence of our senses. It seems more the work of magic, than the result of our own skill and enterprize. All this, too, has been attained in the teeth of old and almost inveterate prejudices; and it is mainly these, which, at this hour, secures employment for the workshops of Europe. Thanks to the skill of our artisans, thanks to an intelligent community, these prejudices are being dissipated; and by stimulants such as these exhibitions afford, and by the dissemination of sound practical science, we may yet see our own manufactures universally preferred: and without the slightest purpose to pay a flattering compliment, may we not add, that, with our fair country women rests much

of the patronage which the arts require? And shall they not receive it?

We are not of the number of those who hold in horror a manufacturing population. We do not believe that such a class will be ever overworked, or starved, in this country. It is too capacious for such results. When we contemplate the extent of territory, the variety of soil and climate, and the difference in habits and pursuits, which these induce, we will, undoubtedly, come to the conclusion, that here all is presented which is calculated to lead to that diversity of occupation which is the true basis of individual and national prosperity.

Manufacturing establishments and towns we will, undoubtedly, have: we have them even now, and they are distinguished for their order, intelligence and morality, no less than for their industry.

But our manufacturing establishments will be located just where they can be conducted most advantageously for obtaining supplies, and securing a steady and profitable market—they will keep pace with population and wants. The extent of our country precludes the idea of any one section becoming the entire manufacturers for the other sections of the country; particularly of such articles as are indispensable to the wants and comforts of society. We already see such establishments springing up in the south and west; and we expect to see, in every State possessing the proper requisites, a due proportion of manufacturing establishments.

Our citizens understand their interests too well to send the produce of their farms, by long and expensive routes, to a market, and by the same expensive routes to obtain all their supplies of manufactured goods. They will have in their midst the artisan who can manufacture for them, and who will, at the same time, become a steady and profitable customer for agricultural products.

While we entertain these views, we freely admit that there are locations, which, from their peculiar facilities for obtaining all the material for manufacturing, and for distributing goods, must ever possess decided advantages for manufacturing purposes. Such a position is enjoyed by Philadelphia, and it may not be out of place here to remind the citizens of our own loved city, that if Philadelphia is to live and prosper, it must be mainly by the production of her own workshops. The field is large, and the harvest inviting and rich. If we fail to reap it, it will be because we are too blind, or indolent, or what may be equally as fatal, too cautious and hesitating in our movements. "There is a tide in the affairs of" cities, as well as of "men, which, when taken at the flood, leads on to fortune."

It is not our purpose to notice the objections urged against a manufacturing population, drawn from their condition in Europe. All that we ask is to let a due proportion of the generation, which are now enjoying the advantages of our public school system, become our mechanics and artisans, and all fears on this subject will be forgotten; and so long as an useful education is provided for every child in the State, such evils cannot long exist. It is wrong, it is unjust, to suppose that intelligent mechanics and artisans are less qualified

for self-government than other classes of society. Intelligent industry dangerous? Why, it is a nation's best security.

This is not the time, nor is it any part of the object of the Franklin Institute, to discuss questions of political economy. The Institute, however, is founded upon the presumption, that, as a great nation, we must and will provide for all our wants and comforts:—no nation can be independent without it.

The objects of the Franklin Institute are the promotion of the mechanic arts; whatever, therefore, will secure these objects, whether it be in the lecture room, the laboratory, by scientific investigations, by publications, or by exhibitions of American skill—these, one and all, the Institute will most unremittingly employ.

We must be pardoned for taking this occasion to speak of the claims of the Franklin Institute upon the citizens of Philadelphia. We do not think that we can be chargeable with presumption, when we say that the Institute has claims, not only upon the manufacturer and artisan, but upon all whose prosperity is involved in the prosperity of Philadelphia.

The Institute has, thus far, been sustained mainly by the labors of a comparatively few zealous, disinterested friends of science and the arts; they have done all and more, by contributions of time and money, than could have been reasonably expected, or asked, of them. The Institute, by attempting too much, has become embarrassed, and its friends must appeal to the citizens of Philadelphia for aid to extricate it from its difficulties, or it may drag on a sickly existence, and, possibly, perish. Should our citizens permit such a result, it may then be found that Philadelphia has lost one of the chief stimulants and aids which has given the productions of her workshops a character unsurpassed, if not unrivaled, by those of any other city in the Union.

The Committee charged with the care of this exhibition would not do justice to their feelings, did they not here acknowledge their indebtedness to the gentlemen composing the Committees of Arrangement and of Judges, who contributed so much valuable time and aid.

In presenting this report, it is due to the makers of the articles deposited to say, that, with very few exceptions, the specimens exhibited are but fair samples of what may be obtained at all times from the manufacturers, or their agents—they were not made with special reference for this exhibition. And it is also proper to say that each specimen has been subjected to a rigid scrutiny, and has not only been compared with similar articles of domestic make, but has also been brought into close comparison with similar articles of old established European makers.

The judges are disinterested men, entirely independent of the parties interested in the issue, and have been selected on account of their practical acquaintance with the articles submitted to their inspection.

It is a subject of regret to the Institute that many beautiful specimens of art, which grace the exhibition, and reflect great credit on

the makers' skill and taste, were not deposited within the time prescribed, and, consequently, could not come under the inspection of the judges.

All that we can report at this time is a list of those articles, which, for their superior excellence, have obtained the award of a premium, honorary mention, or special notice. The report of the judges, in detail, will appear in the Journal of the Institute. As the awards of premiums are read, the President of the Institute will present them to the parties entitled to receive them.

We are also instructed to say, that if any article deposited within the prescribed time, has been omitted by the judges, or, in the preparation of our report, such omission will be corrected, and the article, if entitled to an award, will be reported on immediately before the address, on the last day of the exhibition.

## Report.

*On the Thirteenth Exhibition of American Manufactures, held by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts.*

The Committee on Exhibitions of the Franklin Institute respectfully Report:—

That the exhibition, the awards in regard to which the Committee is about to publish, far exceeds any previous one held by the Franklin Institute. The labors encountered by the members, who were active on the different committees, and the exertions of the depositors have been amply rewarded by the result produced.

It was doubted by many whether the splendid accommodations which the halls of the Museum building afford, were not too extensive for the purpose of our exhibitions. With several departments of manufactures, less fully represented than might reasonably have been expected, we have had abundance from others to fill the space provided, and that bountifully, as well as beautifully. The useful and the ornamental have contended for the palm of public favor, and the throngs which have examined these specimens of native skill and ingenuity, have been more than satisfied, highly gratified, with the increased number and interest of the products set before them, and with the increased facilities for a close examination of the separate specimens.

The usual notices of the time of beginning the exhibition, and of the rules under which it would be conducted, have been rendered public for several months, thereby giving ample time for forwarding, and even preparing (in cases where it was deemed desirable,) articles for exhibition, and preventing, as far as practicable, those mistakes which sometimes deprive deserving competitors of the fruits of their skill, by nonconformity to established rules. Notwithstanding the efforts of the committee in this respect, and of those of the committee of arrangement, many depositors brought articles too late for examination, which otherwise would doubtless have met with attention, and in many cases the reward of the honors of the exhibition.

Under these rules the exhibition opened on Tuesday last, the 17th of October. The activity of the committee of arrangement, to whom the thanks of the Institute are due, gave, at an early date, an earnest of the present happy conclusion of their labors, and if in some cases their just expectations were not realized, the experience gained will be useful on future occasions.

The manufacturers and artisans have fully met the wishes of the Franklin Institute, and of the public. The display of goods in some departments is exceedingly beautiful; the printed cotton goods have attracted universal attention, and received the highest praise; the woolens are thrown into the shade only by the cottons; the silk goods give promise that this branch of manufacture is firmly established among us; the carpets are of beautiful texture, and excellent color, and of a considerable variety of kinds; the oil cloths, which have been improving from year to year, are admirable; the hardware and cutlery are of great variety, and excellent quality, many articles entirely superseding the use of the foreign ones; the iron and steel keeps its rank; the exhibition of lamps and gas fixtures surpasses all former ones; the stoves and grates still improve; the cabinet ware and furniture take a new rank for beauty of form and exquisite finish; the musical instruments improve greatly in average quality; the books and stationary, the bookbinders' tools, the chemicals, the straw goods, the surgical instruments, the paints and colors, maintain their rank, and some of the departments have even advanced; the hats and caps, the coach work, the leather and morocco were exhibited in quantities, and of a quality, to satisfy all; the boots and shoes are excellent; the philosophical apparatus has manifestly improved. These are among the departments which have chiefly contributed to give to this exhibition the character already assigned to it.

The committee has closely adhered to its published programme, in the arrangements of the exhibition, and, aided by the promptness of the committee of judges, is now prepared, on the appointed day, to publish the awards made by them to the makers and depositors of articles examined.

In presenting the results of the reports of the judges, and of their deliberations upon them, the committee intends to be very plain in speaking of the merits, or demerits, of different departments of the exhibition. The real, substantial merits of the whole are too great to be depreciated by such a course. The committee feels too certain of this to fear. On the other hand, our mechanics and manufacturers, and the public, all of them parties whom the Institute should serve, will gain by candor. The Franklin Institute, the committee trusts, will never attempt to make capital by flattering words, or undue praise.

## I.—*Cotton Goods.*

The display of Cotton Goods, especially of Cotton Printed Goods, was the pride of the exhibition, reflecting great credit on the establishments whence they came. Their tasteful display by the depositors, under direction of the committee of arrangement, rendered the speci-

mens exceedingly effective. When the material, as well as the printing, shall be American, there can be nothing more to be desired in this department, but its regular and steady forward movement with all other branches of art. The beautiful variety of patterns, the skill in the combination of colors, the exquisite beauty of the colors themselves, could not be examined without glowing admiration.

The awards in this branch will be found liberal, in proportion to the excellence just set forth. The committee has followed closely the recommendation of the judges.

No. 2, by Benjamin Marshall, of New York Mills, Whitestown, New York, deposited by John W. Downing, fine bleached longcloths, "believed to be the best ever made in the United States," and rivaling the British longcloths. A Silver Medal.

Nos. 150 to 155, by J. Dunnell & Co., Pawtucket, Rhode Island, for beautiful printed cotton goods, "combining elegance of design, brilliancy of coloring, and accuracy of execution in an extraordinary degree," deposited by David S. Brown. A Silver Medal.

Nos. 13 and 173 to 179, by Benjamin Cozzens, Providence, R. I., for beautiful printed goods, combining the same qualities with the articles last named, deposited by Lippincott, Way & Wolcott, and by Austin Scott. A Silver Medal.

No. 202, by A. Robeson & Son, of Fall River, Mass., deposited by Hacker, Lea & Co., printed cottons and printed lawns, of qualities enumerated in the foregoing. A Sliver Medal.

Nos. 188 to 197, and 199 to 201, by Perkins & Wendell, of Bustleton, Philadelphia county, deposited by David S. Brown & Co., and by C. W. Churchman, a superb display of printed cottons and printed lawns, balzerines, and mousselines de laine, possessing the same qualities as the foregoing. A Silver Medal.

It is to be understood that the last four awards are made for the printing of the goods.

No. 49, Preston longcloths, by the Lonsdale Company, Providence, R. I., an excellent shirting, deposited by Wood & Abbott.
A Certificate of Honorable Mention.

No. 20, by R. Beath, of Philadelphia, Earlston ginghams, deposited by Sharp, Lindsay & Haines, a good article, the finish improved upon former specimens. A Certificate of Honorable Mention.

No. 40, by Hood, Simpson & Co., of Philadelphia, ginghams, in imitation of the Manchester ginghams, deposited by John Simpson.
A Certificate of Honorable Mention.

No. 47, by John Elliott, of Philadelphia, deposited by Bingham & Kintzle, well made imitation linen diaper.
A Certificate of Honorable Mention.

No. 9, by Thomas Brown, of Blockley, Philadelphia county, deposited by E. Pilling, of Philadelphia, very good striped tapes.
A Certificate of Honorable Mention.

No. 233, by James Wright, of Philadelphia, Turkey red yarn, much improved upon the specimens submitted last year.
A Certificate of Honorable Mention.

Nos. 159 to 165, the American and Hamilton Print Works, and Joseph Ripka exhibit favorable specimens of their skill.

### II.—*Woolen Goods.*

The specimens in this branch were highly creditable to the manufacturers.

The judges recommend, and the committee makes the following awards:—

Nos. 100 to 106, by S. Slater & Sons, Webster, Mass., deposited by D. S. Brown & Co., black cloths, wool dyed, beautifully finished, regarded by the judges as the best in the exhibition—a silver medal.

Nos. 117 to 122, by Edward Harris, of Woonsocket, R. I., deposited by David S. Brown & Co., merino cassimeres, very superior, and showing great improvement—a silver medal.

Nos. 58 to 95, by the Middlesex Manufacturing Company, of Lowell, Mass., deposited by Stone, Slade & Farnum, cloths and cassimeres, of good quality—a certificate H. M.

The judges notice with approbation Nos. 131 to 133, by the Gonic Company, Rochester, N. Y., superior blankets, deposited by David S. Brown & Co.; Nos. 134 to 144, by W. & D. D. Farnum, Waterford, Mass., deposited by D. S. Brown & Co., fancy cassimeres; No. 226, by James Martin, of Philadelphia, four vest patterns, considered to be beautiful specimens; No. 252, by John H. Ewing, Washington county, Penn., deposited by Farnum, Newhall & Co., four pieces of wool.

### III.—*Carpets and Oil Cloths.*

Few departments of the exhibition attracted more attention than this from the intrinsic excellence of the specimens, and the superiority over exhibitions of former years.

In compliance with the indications of the judges' report, the committee awards:—

No. 21, by W. H. Knight, Saxonville, Mass., deposited by W. D. Hasting, a beautiful specimen of fine ingrain carpeting, the best exhibited—a silver medal.

No. 211, by Andrew McCallum & Co., Germantown, Philadelphia county, the best specimen of Brussels carpeting exhibited—a silver medal.

No. 25, by John Rosencrantz, Manayunk, Philadelphia county, a superior velvet-pile carpet—a silver medal.

No. 227, by Isaac Macauley & Co., of Philadelphia, oil cloths for floors, of large size and excellent quality—a silver medal.

The table oil cloths of Andrew Johnson, of Cincinnati, Ohio, No. 27, fully sustain the reputation of the manufacturer.

### IV.—*Silk Goods.*

The increasing number and variety of articles in this department give evidence, year by year, of a steady and regular growth. The judges appeared to have examined the various articles minutely, and in accordance with their recommendation, the following awards are made:—

No. 224, by John W. Gill, of Jefferson county, Ohio, a collection of silk goods of various kinds—a silver medal.

This collection includes quantities of from one to twelve yards of heavy triple piled velvet, eight thread satin vesting, figured vesting, black serge, flowered silk, colored cravats, handkerchiefs, heavy crimson, white and blue amozine, black and white silk stockings, &c. The raw silk is understood to be grown by the farmers in the neighborhood of the manufactory.

No. 30, by the New York Dyeing and Printing Company, Staten Island, deposited by Mitchell, Brognard & Co., thirty-four pieces of Pongee handkerchiefs, the printing executed in this country—a certificate H. M.

No. 50, by the Philadelphia Silk Manufacturing Company, deposited by J. C. Coppuck, one case of sewing silks, considered by the judges to be the best in the exhibition—a certificate H. M.

The judges mention with approbation, specimen No. 222, fifty pieces of union galloons, by Edward S. Richards, of Philadelphia, deposited by Piggott & Richards.

They likewise examined specimens of gloves, and speak well of No. 5, two dozen pairs of men's royal buck gloves, by John J. Tavener, of Johnstown, N. Y., deposited by Bettle Paul, the article being one which may compete successfully with the foreign.

They recommend, and the committee awards, to 221, by Enos Cooper, of Philadelphia, one dozen and a quarter of men's kid gloves, considered to be equal in quality to the imported—a certificate H. M.

No. 273, by J. R. Ashford, of Philadelphia, six dozen of kid gloves, of a quality similar to the last mentioned—a certificate H. M.

The judges also mention with commendation No. 1, a case of silk stocks, by C. A. Walborn; No. 6, a case of raw sewing silks, by Mrs. Waples, of Sussex county, Delaware, the production of a private family; No. 907, silk suspenders, by Solomon Dœbely, of Philadelphia; No. 11, a case of satin stocks, by S. A. Sendos, of Philadelphia, some of the stocks being made of American silk; No. 97, one case of silk goods, which compare favorably with the Chinese article of the same kind, by Benjamin H. Hooley, of Philadelphia; No. 98, a lot of silk handkerchiefs printed in the United States, at the Thornton Print Works, deposited by Simpson & McGregor; No. 213, by George W. Ward, of Philadelphia, one case of fashionable stocks; No. 38, a case of stocks, by Mrs. A. J. Kneeland; No. 218, silk stocking, made and deposited by Amy Jones, of Camden, N. J.; and No. 353, by J. T. Whitecar & Co., of Philadelphia, one case of suspenders, chiefly of silk and gum elastic, and parts of which are lined with canvas.

## V.—*Iron and Steel.*

The samples of Iron and Steel, submitted at the exhibition, have been carefully examined by the judges, have stood their tests well, and afford gratifying proofs of the progress of this important branch of manufacture. The judges recommend the following awards, which are accordingly made by the committee:—

No. 1705, by Savery & Co., of Philadelphia, specimens of hollow-ware, and other castings of great excellence—a certif. H. M.

Nos. 1649 to 1651, deposited by Morris & Jones, of Philadelphia, an excellent collection of specimens of iron, in different stages of manufacture—a certif. H. M.

No. 1625, by J. L. Mott, of New York, a cast-iron bathing tub, of good form and size—a certif. H. M.

No. 1599, by John Robbins, jr., of Kensington, blistered steel, made from Swedish iron—a certif. H. M.

The judges speak favorably of the specimens of Round and Flat Iron, from the Colemanville Iron Works; of some of the hammered iron from William Dowling, of Mary Ann Forge, Chester county; of the nail rods from the Colemanville Works, deposited by Morris & Jones; of those from Valentine & Thomas, deposited by Isaac Miller; and from the Howard Iron Works, deposited by E. J. Etting & Brother.

The Imitation Russia Sheet-iron, by James Wood & Sons, maintains the high character which induced the Institute to award to it a silver medal at the last exhibition. The attempt of Mr. Thomas Speakman, of Philadelphia, to imitate the Russia iron, is mentioned as worthy of encouragement. The sheets of Boiler Iron, deposited by William F. Potts, and made by S. Hatfield, also those deposited by Morris & Jones, are commended by the judges.

The report of the judges will be published in full.

### VI.—*Umbrellas, Etc.*

The display of Umbrellas, Parasols, and Sun Shades, was creditable to the manufacturers. In accordance with the tenor of the observations of the judges, the committee awards:—

No. 268, by Messrs. W. & W. H. Richardson, of Philadelphia, for an assortment of parasols and sun shades, a new pattern—a certif. H. M.

No. 247, by W. A. Drown, of Philadelphia, for an assortment of parasols and sun shades—a certif. H. M.

### VII.—*Lamps and Gas Fixtures.*

The display of these articles has never been surpassed in beauty at any former exhibition. The judges devote a considerable portion of their report to a notice of the beautiful articles which formed the greater, as well as the most admired, part of this collection, produced by Cornelius & Co. The richly ornamented gas pendants in ormoulu, and the silvered chandeliers and candelabra are particularly referred to, as well as the solar and lard lamps from the same manufactory. This report will hereafter be published; the committee now awards in accordance with its recommendation:

Nos. 1235 to 1242, by Cornelius & Co., of Philadelphia, a rich display of chandeliers, candelabra and lamps, the forms of which were truly beautiful—a silver medal.

No. 728, by E. Whelan, of Philadelphia, a pair of silvered candelabra—a certif. H. M.

No. 1257, by J. S. Gold, of Philadelphia, an assortment of camphine lamps and chandeliers—a certif. H. M.

No. 1372, by Ellis S. Archer, of Philadelphia, various lard lamps—a certif. H. M.

No. 656, by Filley & Kisterbock, of Philadelphia, for various lard lamps—a certif. H. M.

## VIII.—*Hardware and Cutlery.*

Notwithstanding the number and variety of the articles exhibited in this line, they appear to have received close and careful examination. The Committee of Judges, as in so many other cases, regrets that many specimens were brought to the exhibition too late to come under their notice.

The judges recommend, and the committee sanctions, the following awards:—

R. & W. Robinson, of Attleboro', Mass., for No. 634, deposited by Colladay & Brother, one case of gilt metal buttons, of exquisite finish —a silver medal.

Ibbotson & Horner, of New York city, for No. 725, deposited by Savery & Co., one box of horse rasps, and three square files, of excellent material and workmanship, eighteen dozen of three square files, of assorted sizes, being exhibited—a silver medal.

The following named articles, which received premiums at the last exhibition, are spoken of as fully sustaining the character then acquired:—The wire cloth, No. 620, by J. Mecredy, of Philadelphia; the files and rasps, No. 621, by G. Machin, of Philadelphia; the pocket and pen knives, No. 633, by Bradley & Beecher, of Naugatuck, Conn., deposited by Heaton & Denckla; the screws, No. 682, made by the New England Screw Company, Providence, R. I., and deposited by Curtis & Hand.

The following awards, recommended by the judges, are also confirmed.

Wadhams, Webster & Co., of Wolcottville, Connecticut, No. 616, a case of gilt buttons, beautifully finished—a certif. H. M.

H. Huber, jr., Philadelphia, for No. 644, one case of saddlers' tools, highly commended by the judges—a certif. H. M.

W. Reed & Co., of Philadelphia, for No. 675, one card of brass cocks, of superior workmanship—a certif. H. M.

No. 1705, Savery & Co., of Philadelphia, for butt hinges and sad irons, of an admirable quality and appropriate finish; the butt hinges being considered the best exhibited—a certif. H. M.

A number of specimens of butt hinges were presented for competition, and the judges speak favorably of No. 661, a card of cast-iron butt hinges, by J. L. Johnson, of Philadelphia, deposited by Steinmetz & Justice; of No. 662, a similar article, by Thomas Loring, of Philadelphia, deposited by W. Hart Carr; of No. 701, the same article, by Stewart, Biddle, Lloyd & Co., of Danville, Penn., deposited by W. P. Cresson & Brother.

Special notice is taken of No. 694, one case of saws, and one circular saw, by J. Wood & Sons, of Philadelphia; of No. 703, locks of a peculiar construction for mortise door locks, by T. L. Littlefield, of Philadelphia.

This latter article should be referred for examination to the Committee of Science and the Arts.

The following articles are also noticed with approbation by the judges:—

No. 627, six pair of iron chains, made by J. & E. M. Smith, of Hamburg, Pa., and deposited by Shipley & Warner.

No. 629, well finished coopers' tools, by Barton & Smith, of Rochester, N. Y.

No. 645, five rifles, by John Krider, of Philadelphia, deposited by J. T. Siner, fully sustaining the reputation of the maker.

No. 659, planes made by David Colton, of Philadelphia, the best specimens exhibited.

No. 663, iron and tinned iron rivets, by Holmes, Edes & Co., of North Marshfield, Massachusetts, deposited by Heaton & Denckla.

No. 712, a well made rifle and appliances, by T. T. Subers, of Philadelphia.

No. 715, four scythes, by O. Hunt & Brother, of Stavesville, deposited by Heaton and Denckla.

No. 716, six scythes, by Inman & Co., of Slatersville, Pa., deposited by Heaton & Denckla.

The judges remark that the home manufactured scythes have entirely superseded the use of the imported articles.

The articles of Britannia Ware are thought by the judges to give earnest of improvement; they particularly mention No. 654, by J. H. Palethorp & Co., of Philadelphia, and No. 657, by Boardman & Hall, of Philadelphia.

The excellent locks of Prutzman came too late for competition.

### IX.—*Saddlery, Harness, and Trunks.*

The judges are of opinion that there should have been a greater variety in the articles in this department, to have given a fair representation of the condition of the art. The articles deposited were, however, generally of a good quality. In conformity with what is understood to be the recommendation of the judges in the report, the committee awards:—

No. 328, by James E. Brown, of Philadelphia, well made trunks—a certif. H. M.

No. 380, by Jacob Moyer, of Philadelphia, a beautiful traveling trunk—a certif. H. M.

No. 366, by E. P. Moyer, of Philadelphia, a well made trunk—a certif. H. M.

No. 352, by John Unruh, of Philadelphia, a traveling trunk with white nails, beautifully finished—a certif. H. M.

The harness by Lacy, sustains, in the opinion of the judges, his high reputation. A leather trunk, by Adriance, No. 342, is spoken

of with praise, also both specimens of medical bags, by S. F. Summers, No. 315, and by A. M. Martin, No. 389.

The assortment of Whips was good.

The Harness Ornaments, No. 362, of J. Welsh, of Philadelphia, deposited by S. R. Phillips, are worthy of notice.

### X.—*Models and Machinery.*

The collection of Models and Machinery was not such in quantity or variety as fairly to represent the condition of the Mechanic Arts, even in our city. There can be no doubt that our workshops have felt the influence of the depressing circumstances of the years just past, but there can also be no doubt that a much more creditable display might have been made, had our workmen felt more fully that their interest and reputation were at stake. Whole branches known to be in active operation were unrepresented by even a single machine. This is the more to be regretted that considerable expense was incurred to provide most ample accommodation for heavy machinery. It is true that many of the articles exhibited were highly creditable to the manufacturers, and that after the date at which, by the rules of the Institute, notice could be taken of specimens, many excellent articles were brought into the rooms, but still this department of the exhibition was not what it might have been. The committee submits to the Philadelphia mechanics whether this state of things is fair to the Institute, or to the public, and hopes that on another occasion this department will bear quite a different character.

The judges recommend, and the committee makes the following awards:—

No. 1538, by James & Joseph Albertson, of Philadelphia, a skiff, with an oak frame and cedar planking, of beautiful workmanship—a silver medal.

No. 1631, by Charles Evans, of Philadelphia, copying presses, of excellent workmanship—a silver medal.

No. 1503, by James Brooks, of Frankford, Pennsylvania, a horizontal steam engine, a good and serviceable piece of work—a certif. H. M.

No. 1504, by J. W. & J. F. Starr, of Kensington, a locomotive boiler, considered to be an excellent specimen of work—a certif. H. M.

No. 1530, by E. G. & R. O. Tripp, of Trenton, N. J., deposited by A. Quintin, of Bristol, Penn., a box of shuttles—a certif. H. M.

No. 1531, by J. D. Dale, of Lansingburg, N. Y., deposited by Gray & Bennett, of Philadelphia, four platform scales—a certif. H. M.

No. 1577, by Stephen Ustick, of Philadelphia, a log brace for saw mills—a certif. H. M.

No. 1582, by Jacob Lodge, of Philadelphia, an apparatus for corking bottles to contain effervescing waters—a certif. H. M.

No. 1583, by D. O. Prouty & Co., of Philadelphia, a sub-soil plough —a certif. H. M.

No. 1626, by Jordan L. Mott, of New York, a stationary cowl, or ventilator, shown by the experiments of Mr. Ewbank, to answer its purpose well—a certif. H. M.

No. 1617, by David Evans, Philadelphia, a fire proof chest, water coolers and filters—a certif. H. M.

No. 1618, by John McConn, of Philadelphia, deposited by Carter & Parham, hatters' heating irons—a certif. H. M.

No. 1619, by George Snyder, Philadelphia, for well shaped, smooth, and dense bricks—a certif. H. M.

No. 1654, by G. W. Metz, Philadelphia, for a well made blacksmith's bellows, with a new mode of inserting the pipe—a certif. H. M.

No. 1661, by Joseph Laubach, deposited by John Murphy, a patent blacksmith's tuyere, furnishing an efficient blast from the bottom of the fire—a certif. H. M.

No. 1665, by William Elliott, Francisville, near Philadelphia, a model of a hipped roof, slated with specimens of different kinds of work of excellent finish—a certif. H. M.

No. 1689, by Greer, Amer & Newell, Philadelphia, a small steam engine, well contrived and executed—a certif. H. M.

The lathe of John H. Schrader, reported by the judges for a certificate, was too late for competition.

To Gideon Cox, Philadelphia, for the deposit of various specimens of wooden ware for household use—a certif. H. M.

To Landreth & Munns, Philadelphia, for an exhibition of agricultnral implements and tools—a certif. H. M.

To D. O. Prouty, Philadelphia, for an exhibition of similar articles —a certif. H. M.

To Edwin Chandler, Philadelphia, for a similar display of implements—a certif. H. M.

To James Young, Philadelphia, patent agent for a number of ingenious machines, deposited by him—a certif. H. M.

The utility of establishments like these, where agricultural and other implements and machines for various purposes may be found by purchasers, who often require advice in regard to their choice and use, induces the committee cheerfully to make awards to these gentlemen for the variety of specimens deposited by them.

The judges are of opinion that the self-adjusting counter spring, by Oliver Evans, of Philadelphia, and Cottrell's lattice weighted bridge, should be presented by their inventors for the examination of the Committee of Science and the Arts.

The minute report on this department will be hereafter published; it closes with a regret that many articles of value were deposited too late for competition, or notice.

The judges speak approvingly of No. 1570, by J. Dutton, Delaware county, an apparatus for distributing water in thin sheets, to promote its freezing; of No. 1596, by George W. Duncan, Philadelphia, an abridged set of stencil plates for marking; of No. 1598, by William M. Davis, Philadelphia, a small lathe of good workmanship; No. 1634, by Ellis Jackson, Philadelphia, well made shuttles for weavers; No. 1640, by Jacob Senneff, Philadelphia, a power loom shuttle, of neat workmanship; No. 1702, by Mahlon Gregg, Philadelphia, a machine for cutting tenons.

## XI.—*Stoves, Grates, Etc.*

The spirited competition which exists in these important articles, always secures an excellent display of them at our exhibitions. On the present occasion the means of exhibiting practically the good qualities of the Stoves and Ranges, were as ample as could possibly be desired. The detailed report of the Committee of Judges will be published in the Journal of the Franklin Institute, thus furnishing more minute information in regard to the several articles exhibited, than can be given in the compass of this report.

Upon the recommendation of the judges, the following awards are made :—

No. 1501, by Pleis, Fœring & Thudium, Philadelphia, for a radiator stove—a certif. H. M.

No. 1620, by Jacob F. Pleis, Philadelphia, for a radiator stove—a certif. H. M.

No. 1707, by Weaver & Volkmar, Philadelphia, for a radiator stove—a certif. H. M.

No. 1720, by Williams & Hines, Philadelphia, for a radiator stove —a certif. H. M.

No. 1714, by J. W. Kirk, Philadelphia, deposited by Williams & Hines, for a crescent radiator, of new and curious arrangement—a certif. H. M.

No. 1721, by A. Brenizer, Philadelphia, for an air-tight stove, for wood—a certif. H. M.

The Ornamental Stoves, as well as the Cooking Stoves and Ranges, resembled very much those exhibited during the two years last past.

Farther awards are made, on the recommendation of the judges.

No. 1608, a cooking stove, by S. R. Sank, deposited by T. Durell —a certif. H. M.

No. 1698, a cooking stove, by J. Kisterbock—a certif. H. M.

No. 1686,a summer stove and baker, by M. Stewart—a certif. H. M.

No. 1528, by Lloyd & Feltwell, Philadelphia, a cooking range—a certif. H. M.

No. 1557, by Julius Fink, Philadelphia, a cooking range—a certif. H. M.

The two ranges just named have taken a premium at former exhibitions, and can, therefore, now, according to rule, have no other testimonial than the certificate, which shows them so far to be in the first rank.

No. 1534, a cooking range, by F. McIlvaine, Philadelphia—a certificate H. M.

No. 1567, a cooking range, by Henry Hallman, Philadelphia—a certif. H. M.

To Jordan L. Mott, New York, for the extensive and creditable display of stoves, furnaces, boilers, &c., deposited by De Witt C. Mott —a certif. H. M.

No. 1559, by C. W. Warnick, Philadelphia, for a similar exhibition —a certif. H. M.

## XII.—*Cabinet Ware.*

The specimens of Cabinet Ware exhibited this year, fully sustained the reputation of our manufacturers, which is deservedly very high; it was, however, a subject of remark that on an occasion where so excellent an opportunity for the display of a large number of articles had been provided, by furnishing ample space for exhibition, the number fell short of those of the exhibition of last year. In the opinion of the judges, many of the articles exhibited were beautiful models of taste, ingenuity, and excellent construction, challenging competition, especially in the last named quality.

The committee makes the following awards, recommended by the judges:—

Nos. 1319 to 1321, by J. & A. Crout, Philadelphia, a centre table, and other articles of American woods—a silver medal.

The committee particularly recommend this branch of art to the fostering care of the Institute, and are of opinion that the specimens just named are not excelled by the productions of the like sort in any country, in regard to which they have had full opportunities of being informed.

Nos. 1330 to 1332, by Charles H. & J. F. White, Philadelphia, articles of furniture in the Gothic style, of excellent workmanship, and tasteful design—a silver medal.

Nos. 1222 to 1225, by Alphonse Quantin, Philadelphia, deposited by A. Lejambre, furniture in the style of Louis XVI, (renaissance) of rich materials and good workmanship—a certif. H. M.

No. 1293, By Benjamin J. Williams, Philadelphia, Venetian blinds, of good construction and excellent finish—a certif. H. M.

The specimens of painting in wood, by John Gibson, exhibited in numerous articles, were much admired. The committee awards a certificate of H. M.

## XIII.—*Musical Instruments.*

Superior facilities were afforded this year for the exhibition of Musical Instruments, and the number and variety were considerable. The judges are of opinion that most satisfactory proof was afforded of progress in this branch of art. The elaborate report of the judges will be published in the Journal of the Institute. The Committee on Exhibitions having maturely weighed the subject, and compared the principles which govern the award of the honors of the Institute in other departments, with those laid down by the judges, in reference to their recommendations in this, are constrained to raise the grade of award to different competitors, while the comparative scale presented by the judges is strictly adhered to. The committee, therefore, awards:

No. 209, A, by Messrs. Gale & Co., New York, deposited by J. C. Smith, a piano, considered by the judges to be one of the two best of its kind in the exhibition—a silver medal.

No. 1271, by Conrad Meyer, Philadelphia, a piano, deemed by the judges to be one of the two best of the kind in the exhibition—a silver medal.

The only grand piano exhibited was from the manufactory of Thomas Loud, Philadelphia, but so many excellencies were found in it by the judges, that the committee does not hesitate to award to No. 1302, by Thomas Loud, Philadelphia, a grand piano, combining various excellencies of construction—a certif. H. M.

The committee further awards to,

No. 1346, by C. F. Martin, Nazareth, Pa., deposited by F. Peale, a Spanish Guitar, of graceful proportions, and very fine tone—a certificate H. M.

The judges speak with praise of the seraphina, No. 1178, by Chris. Knaurr, and the case of wind instruments, No. 1266, by Thomas W. Weygandt; of the pianos of the Philadelphia Manufacturing Company, Messrs. Groves, Loud, Miller, Reichenbach, and Betts.

The committee also awards to

No. 1201, a parlor organ, by Henry Corrie, deposited by James Cox, novel in some of the arrangements, and of good tone—a certif. H. M.

The parlor organ, No. —, by Joseph Buffington, deserves notice as the highly creditable work of a self-taught young man, who has devised and executed every part of it without assistance, or other instruction than he could derive from books, and the occasional conversation of a friend.

## XIV —*Glass and China.*

The display in this department was not equal to that at the last exhibition, nor did it do justice, much less credit, to the sate of the manufacture in the country. The judges very justly remark that "Philadelphia furnishes a market for a large amount of Glass Ware, and the manufacturers of the article would certainly have advanced their interests had they submitted to the public, through the exhibition, a better variety of what they were capable of producing in their respective factories." In pursuance of the recommendation of the judges, the committee awards:

No. 601, made by P. C. Dummer & Co., of Jersey City, deposited by E. E. Smith, a cut glass bowl, of graceful form and good finish, and of a superior quality of material—a silver medal.

No. 713, by the New England Glass Company, Boston, deposited by S. D. Hastings, several pairs of cut glass salts—a certif. H. M.

No. 614, made by T. Richards, Philadelphia, samples of window glass, of pure material, and free from waves—a certif. H. M.

The judges speak in terms of high praise of No. 646, samples of pottery from the manufactory of Abraham Miller; but as Mr. Miller is one of the Board of Managers of the Institute, the rules forbid any award in this case. They also commend No. 722, specimens from the American Pottery Company, Jersey City. The Committee of Exhibitions refers to the report of the judges, which will be published hereafter, for excellent remarks in reference to this useful branch of manufacture.

No. 652, a cut glass decanter, with nine compartments, was much admired.

### XV.—*Books and Stationary.*

The display in this department has fallen off at the last two exhibitions; a wrong done by manufacturers to themselves, as well as to the public. The judges have not recommended any special awards, but from the terms of their report the committee awards:

No. 180, by S. Moore, Philadelphia, deposited by Carey & Hart, books in a great variety of bindings, remarkable for neatness of execution, and good taste—a certif. H. M.

The case in the Gothic style, in which these books were contained, by J. Blair, the painting by Gibson, was much admired.

No. 1289, a map of the United States, by Mitchell, the smaller size, done on wood and stereotyped—a certif. H. M.

The judges speak in commendation of No. 19, a map of the United States, by Sherman & Smith; No. 210, well made slates, from Samuel Taylor, Easton, Pa.; No. 1550, slate pencils, of admirable material, but too roughlyfinished; No. 1203, a map of Philadelphia county, by J. H. Young; No. 212, deposited by J. B. Lippincott & Co., American elastic inkstands, of various sizes; No. 254, wood type, for fancy work, by Wells & Webb, New York; No. 26, by Lindsay & Blakiston, a number of beautifully bound books.

The committee coincide entirely with the judges in their expression of disapprobation, in regard to the foreign stamps and names put by some of our manufacturers upon their goods.

### XVI.—*Paper Hangings.*

At the last two exhibitions, this department attracted much of the attention of visiters, from the number and excellence of the specimens. The results to the manufacturers were immediate. On the present occasion the specimens show that there has not been a falling off in the quality of the articles, but the quantity was too small to excite attention. This is the more to be regretted when the present rooms offer so excellent an opportunity for the display of wall papers. The committee hope that the public may be more respectfully considered on a future occasion.

### XVII.—*Fine Arts.*

The subjects more particularly appropriate to an exhibition like ours, are not those which constitute the most attractive parts of a picture, or statue, gallery. It is difficult, however, to draw the line between the appropriate and inappropriate, and when artists of merit, in the higher walks of the fine arts, submit their productions to the public through the medium of our exhibitions, it is right to acknowledge their sense of their merits. The committee awards as follows:

No. 1221, by G. W. Conarroe, Philadelphia, a portrait of the Hon. Calvin Blythe, and a portrait of a lady—a certif. H. M.

No. 1215, by W. Warner, Philadelphia, a collection of mezzotint engravings—a certif. H. M.

The "Arm Chair," a picture by Mr. Warner, referred to by the judges, was too late for notice.

Nos. 1279, 1280, and 1294, portraits in water colors, by M. S. Parker—a certif. H. M.

The judges speak in terms of praise of the design for a monument, and for a fountain, by J. C. Trautwine, and of the water color drawings, by Wm. Mason, and of the wood engravings generally.

The committee award No. 1267, by C. B. Ives, Philadelphia, for a marble bust—a certif. H. M.

The committee notice with commendation the collection of Daguerreotype miniatures, No. 1317, by J. Plumbe, jr.

The splendid full length picture of Henry Clay, for which the exhibition was indebted to Mr. Neagle, was deposited too late to be noticed by the judges.

## XVIII.—*Silver Ware and Jewelry.*

The number of articles of Silver Ware exhibited this year was considerable, and their finish admirable. The exhibition of Jewelry, on the contrary, was smaller. The judges recommend the following awards, which are made accordingly:

No. 642, by Messrs. R. & W. Wilson, Philadelphia, containing two plain tea-pots, and a pair of oyster dishes, particularly noticed as showing good hammering and fitting—a certif. H. M.

The judges refer particularly to a pitcher of chased work, No. 608, by Bard & Lamont, commending the mechanical execution, while they disapprove of the design. They are of opinion, that, in general, in this branch, purity of design, and perfection of form, are not sufficiently studied. Without these, exquisite polish, and beautiful chasing serve but to cover defects which they cannot hide.

## XIX.—*Bookbinders' Tools.*

The competition in this branch is always very limited, from the intrinsic circumstances of the art itself. The specimens at this exhibition fully sustain the high reputation of those depositors whose specimens came in time to be examined by the judges, under the published rules of the exhibition.

The judges mention especially the brass tools of Messrs. Gaskill & Copper; a steel embossing plate, by A. C. Morin; the designs by Chapman, Persell & Thompson, of New York, and the steel plates for engravers, by the same firm.

## XX.—*Marble Work.*

There were so few articles in this line in the exhibition as to produce general surprise; the meagre collection not corresponding to the known variety of Philadelphia marble work.

The judges speak favorably of, and the committee awards a certificate of honorable mention to No. 1292, a mural tablet, by Ferd. H. Strecker.

## XXI.—*Hats and Caps.*

The display in this department was admirable indeed, far surpassing even that in 1840, when there was so much competition among

the makers and finishers of these articles. The judges have performed their duty in a way not to be surpassed, but find excellence so general, that after their minute examination they are at a loss to recommend awards which shall place one competitor above another. Their minute and well prepared report will be published for the information of all concerned, and the committee hopes that the hints given in it will not be lost upon manufacturers in this line. The committee regrets that they cannot comply with the wishes of the judges in regard to articles deposited after 12 o'clock on Tuesday last, even under the very strong circumstances which they present: the rule must be absolute, or it must give rise to exceptions which no impartiality, or sagacity, on the part of the Committee of Exhibitions could meet.

In accordance with the explicit recommendations of the judges, the committee awards:

No. 976, by Orlando Fish, New York, deposited by C. A. Walborn, three nutria and three moleskin hats—a certif. H. M.

No. 997, by John C. Yeager, Philadelphia, hats of "neat appearance, excellent color, and moderate prices"—a certif. H. M.

No. 1072, by E. Kimber, jr., Philadelphia, a case of hats, two fur bonnets, and a fancy hat for a child—a certif. H. M.

Special praise is given by the judges to the following named among the depositors whose goods were in the hall in due time:—to John Hill, Philadelphia, for a nutria and a moleskin hat, of good finish and color, and very light; to Mrs. Hill, Philadelphia, for two children's caps; to Oliver Brooks, Philadelphia, especially for his cassimere hats; to Messrs. Lamberti & Blynn, for a case of hats, distinguished for neatness of style.

The beautiful case of hats, by Charles Bulkley, was too late for competition.

The judges trace the improvement in this branch of manufacture to the competition in trade, and particularly to the stimulus afforded by the exhibitions of the Franklin Institute. Those who do not succeed in obtaining praise at one exhibition, have but to make the requisite improvement to attain this result the following year, and all have an opportunity to exhibit their goods to thousands of examiners who may become purchasers.

### XXII.—*Combs and Brushes.*

The competition in these articles was very small, and the judges do not recommend any special awards.

### XXIII.—*Coach Work.*

The specimens in this branch of art were very beautiful. Many were remarkable for taste of model and coloring, and for ingenuity of construction, combining strength with lightness. The judges specially commend the following articles, to which awards are made:

No. 1593, by Joseph Glenat, an omnibus for thirty passengers, sixteen feet long, of superior workmanship, and admirably contrived for the purpose of a pleasure omnibus—a silver medal.

No. 1565, by A. Knowles, Philadelphia, deposited by the maker, the best York wagon in the exhibition—a silver medal.

The judges speak with commendation of the workmanship of No. 1551, by George Jeffries, and of No. 1552, by Ogle & Watson, both Rockaway wagons; of No. 1553, a coach, by Ogle & Watson; of No. 1653, a York wagon, by Vansciver & Sons; of the construction of No. 1555, a bow spring carriage, by A. Merritt, Philadelphia.

They also approve of No. 1541, patent harness, by L. Houghton, Boston, deposited by J. Young; of No. 1680, turned spokes, by S. Bedford, Newark, N. J., deposited by H. & J. Fricke; of No. 1681, hardened taper axles, deposited by H. & J. Frick; of No. 1691, taper coach axles and tight boxes, by Greer, Amer & Newell.

## XXIV.—*Leather and Morocco.*

The judges speak in terms of high commendation of the exhibition in this department. Where so much excellence exists, it is difficult to determine between the claims of the several artisans, but the beautiful display which has been brought forward, deserves to be marked by a generous notice. The committee accordingly make the following awards:

Nos. 302 to 304, by Fritz & Williams, Philadelphia, specimens of Morocco—a certif. H. M.

No. 318, by Charles B. Williams, Philadelphia, sides of sole leather—a certif. H. M.

No. 386, by the Boston Manufacturing Company, deposited by John W. Patton, Philadelphia, specimens of patent leather, of beautiful finish—a certif. H. M.

No. 391, by Taylor & Kinsey, Philadelphia, for half a dozen of Madras French Morocco—a certif. H. M.

No. 399, by Scattergood & Boustead, Philadelphia, for six sides of Russet bridle leather—a certif. H. M.

The following articles are noticed with special commendation. No. 321, one chaise hide, by C. & W. Pyle & Co., Wilmington, Del., deposited by J. L. Webb; No. 329, two sides of slaughter sole leather, by John W. Patton, Philadelphia; No. 371, one side of enameled top hide, by J. & R. Ward, of Newark, N. J., deposited by Thomas Mogridge; No. 384, eight calf skins, by C. & A. Dannaker, Philadelphia; No. 392, one goat skin, and one buck skin, by John Ebert & Son, Frederick, Md., deposited by C. A. Walborn; No. 397, two bag-hides, by Scattergood & Boustead; No. 398, six hides of ladies' dressed sole leather, by Scattergood & Boustead, Philadelphia; No. 401, parchment and morocco, by Doyle & McNeeley, Philadelphia; and No. 402, a lot of leather, by Fidel Fisher, Philadelphia.

The number and excellence of the articles now submitted, fully make up for the meagre display upon which the Committee on Exhibitions of last year felt it to be their duty to comment.

## XXV.—*Boots and Shoes.*

The report of the judges is very specific in regard to the awards, and the committee makes them in accordance with it.

No. 375, deposited by William Moyn, Philadelphia, and consisting of gentlemen's boots and slippers, articles combining usefulness, durability, comfort, and good taste—a silver medal.

No. 357, deposited by John Ryan, a case of fancy boots, displaying good workmanship—a certif. H. M.

## XXVI.—*Chemicals, &c.*

The display of Chemical preparations, and of articles submitted with them to the examination of the judges, was highly creditable, superior, in fact, in number and variety of articles to the collection of any former year. The judges have made a very full report, which will be published for the satisfaction of the depositors, and the information of the public.

The judges recommend, and the committee makes the following awards:

No. 309, by Messrs. Wetherill & Brothers, Philadelphia, for a suit of chemical preparations, of great excellence—a certif. H. M.

No. 335, by Messrs. Smith & Hodgson, for the general excellence of the specimens—a certif. H. M.

No. 327, by Lawrence Turnbull, Philadelphia, deposited by Frederick Brown, for the general excellence of the articles—a certif. H. M.

No. 613, by Edward Parrish, Philadelphia, a case of Pharmaceutical preparations, designed for the use of students of medicine—a certif. H. M.

No. 635, by Stephen Heintz, Malaga, N. J., deposited by L. Voigt, a lot of chemical glassware, of approved forms and quality—a certif. H. M.

No. 306 to 308, by Lovering & Co., Philadelphia, loaves and jars of sugar, refined without the use of blood—a certif. H. M.

No. 373, by Charles W. Gschwind, Philadelphia, for beautiful specimens of glue—a certif. H. M.

No. 388, by Hancock & Mann, Baltimore, deposited by White, Warner & Co., for beautiful specimens of their "adamantine candles" a certif. H. M.

No. 351, by Campbell Morfit, Philadelphia, a series of specimens exhibiting the process of manufacture of candles from stearine without saponification—a certif. H. M.

The judges speak in terms of high commendation of the industry shown by Mr. Morfit, in perfecting this important branch of manufacture.

No. 338, by Eugene Roussel, Philadelphia, an admirable exhibition of fancy soaps and perfumery—a certif. H. M.

The judges speak in terms of praise of the chemicals submitted by Messrs. Harrison & Brother; of the acetate of lead, from Mordecai Lewis; of the cyanide of potassium, from H. W. Worthington; of the isinglass, from C. Delacour. Also of the fancy soaps, by Curtis Taylor & Son, and the perfumery, by N. B. Hinton, and by Jules Hauel.

No. 382, by Gerhard Schmitz, Philadelphia, for specimens of chocolate—a certif. H. M.

## XXVII.—*Philosophical Apparatus.*

The display in this department was unusually creditable to the depositors, though the number of those depositing was smaller than on former occasions. The following awards, recommended by the judges, are made by the committee:

No. —, a four feet transit circle, by W. J. Young, Philadelphia, of beautiful workmanship—a certif. H. M.

No. 688, &c., by J. Bishop, Philadelphia, two electrical machines, and other apparatus—a certif. H. M.

No. 709, by James Duffey, Philadelphia, balances for hydrostatic and other purposes—a certif. H. M.

No. 1335, dew point and wet bulb hygrometers and magnetic instruments, by Solon W. Hall, Philadelphia—a certif. H. M.

No. 186, a globe and planispheres, with geographical, &c. lines, for instruction in geography and astronomy, by the Rev. R. Piggot, Maryland—a certif. H. M.

The judges mention with approval No. 708, models of machines, by James Duffey, jr., Philadelphia; No. 360, shades for magic lanterns, by Thomas A. Nolens, Rochester, N. Y.; and No. 700, the dial of the seasons, by Thomas Fisher, Philadelphia.

The neglect of Mathematical and Philosophical Instrument makers to show to the many strangers and citizens who attend our exhibitions, specimens of their handiwork, is commented upon by the judges, with whom the committee fully agree as to the bad policy of the course.

## XXVIII.—*Straw Goods.*

The report of the judges upon these articles will be published hereafter. The committee confines itself to making the awards indicated by the judges:

No. 214, by A. Caseli, New York, specimens of Amazon braid, "purely white, even in texture," and of good quality—a certif. H. M.

The judges notice also with approval, No. 215, Amazon braid bonnets, by S. D. Hall & Co., New York.

Some of the best articles in this department came too late for competition.

## XXIX.—*Surgical Instruments.*

The articles classed under this head have been examined with great care. In conformity with the report of the judges, the committee awards as follows:

No. 707, by M. S. Foster, Trenton, N. J., a set of porcelain teeth, of unusual excellence—a silver medal.

No. 697, by Henry Habermehl, Philadelphia, an artificial hand and legs—a certif. H. M.

No award can be made for No. 672, an abdominal supporter, by Messrs. Wiegand & Snowdon, as Mr. W. is a member of the Board of Managers of the Institute.

No. 660, by Horatio G. Kern, Philadelphia, a case of instruments, chiefly dental—a certif. H. M.

### XXX.—*Gum Elastic Goods.*

There was no competition in these articles generally, but the judges were much struck with the perfection of the articles exhibited by Mr. Thornley, and recommend the following award, which the committee makes:

No. 332, by J. Thornley, Philadelphia, India rubber goods, of admirable quality—a certif. H. M.

The judges speak particularly of the gum elastic over shoes with leather soles, with gum elastic shanks to leather soles; of the gum elastic air mattrasses, and cloth for signs, all contained in the lot just mentioned.

They praise also the shoes, with gum elastic soles, made by John S. Ripley, Philadelphia.

### XXXI.—*Copper, Brass, and Plumbers' Work.*

The assortment under this head was small. The judges mention No. 1529, seven specimens of copper and brass ware, by W. B. Bentley, Philadelphia, as deserving commendation; also No. 1536, a lot of braziers' solder, by William Kent, Philadelphia, as of good color and well grained.

They refer in terms of high commendation to the lead pipe, made by Messrs. Tathem & Brothers, Philadelphia, which has already received a medal from the Institute.

### XXXII.—*Tin Work.*

The judges report that there was nothing worthy of special attention in this line deposited in the exhibition.

### XXXIII.—*Paints and Colors.*

The decisions in reference to relative merit in this department, are difficult to make in the short time allowed by an exhibition. The judges have applied such practical tests as the time permitted, and speak with praise of the following articles:

No. 309, by Wetherill & Brothers, of chrome yellow, of excellent color; No. 409, chrome green, by C. J. Crease; No. 343, red lead and orange mineral, of superior fire, by George Uhler; No. 355, coach varnish, by Wm. M. Humes; No. 325, Osborne's water colors, deposited by Smith & Hodgson; No. 364, rose pink, of superior color, by Charles Hasse.

No. 334, lamp black, by Wainwright & Elliott. The uncalcined lamp black is pronounced to be rather superior, and the calcined, very superior to the English article—a certif. H. M.

The white lead exhibited was of a superior quality; the judges mention particularly a specimen by Wetherill & Brothers, which they recommend to the attention of artists.

The committee awards to No. 309, by Wetherill & Brothers, the smaller samples of white lead, which may, in the opinion of the judges, supersede the Kremnitz white—a certif. H. M.

## XXXIV.—*Fancy Articles.*

This department, as usual, presents articles of very different grades of merit. The judges state that they have examined all carefully, and report those which they consider best worthy of notice. Awards are made to the following named articles:

No. 901, by Thomas B. Smith, Philadelphia, an admirable assortment of pickles, of various kinds—a silver medal.

No. 945, by A. Rudduck, deposited by J. M. Bolton, one case of pearl work, the carving upon which is deemed of excellent quality—a certif. H. M.

No. 951, by Philip Dolflien, Philadelphia, a miniature equestrian statue of Napoleon, in bronze—a certif. H. M.

No. 961, by Sarah Bringhurst, Philadelphia, a knitted bonnet and shawl—a certif. H. M.

No. 999 by W. H. Schreiner, two cases of artificial bait, consisting of flies, "grey hackle," and shrimps, considered by the judges as equal to the English—a certif. H. M.

No. 1009, by J. Doughty, for excellent preserves—a certif. H. M.

No. 1020, by Thomas Bogue, a gossamer wig ,weighing only one ounce, and of admirable finish—a certif. H. M.

No. 182, by C. A. Walborn, a beautiful specimen of corded collars —a certif. H. M.

No. 266, by Mrs. Wright, a linen shirt, the work upon which was much admired—a certif. H. M.

No. 1065, by Miss Johnson, Philadelphia, a splendidly embossed velvet bonnet—a certif. H. M.

No. 1077, by Joseph Sholl, an apiary, of ingenious construction—a certif. H. M.

No. 982, by James Keefe, Philadelphia, three boxes of vermicelli and maccaroni, of excellent quality, the only specimen ever exhibited —a certif. H. M.

No. 984, by Mrs. Ida Neher, Philadelphia, the best specimen of hair work on ivory—a certif. H. M.

The committee awards:

To the pupils of the Pennsylvania Institution for the Instruction of the Blind, for manufactures of tow cloth, rag carpet, rope and baskets —a certif. H. M.

The judges mention with approbation a number of articles.

No. 980, a beautiful specimen of worsted work, by Miss Seeger.

No. 1025, a similar, of raised worsted work, by Mrs. C. R. Fling; No. 1042, a frame of needle work, by Miss Prettyman; No. 985, a wreath and ottoman, by Miss A. Supplee.

The soda water of Eugene Roussel, with the peculiar fastening of the corks to present the escape of gas, fully sustains the high reputation of the article.

Notice is also taken by the committee of
No. 12, a case of ready made linen, by Mrs. S. Sendos.
" 167, " " " P. Chapouty.
" 187, " " " G. W. Ward.
No. 1028, a case of pearl work, B. & A. Waiter.
The committee further awards to
No. 651, by Capewell & Brother, for excellent specimens of sweet chocolate—a certif. H. M.

In conclusion, the committee returns thanks to the judges generally for their promptness in examining and reporting upon the departments confided to them. An unusual number of these reports are prepared with a care which renders them worthy of being presented to the public, and the committee will recommend them for insertion in the Journal of the Franklin Institute; thus, all defects which may be found in the present document will be remedied, and minute information be given in regard to articles, and departments of interest.

The certificates are ready for delivery, and the medals which have not been delivered may be had at the office of the Actuary.

To be Continued.

---

## Mechanics, Physics, and Chemistry.

GLEANINGS FROM FOREIGN JOURNALS.—No. II.

*Proceedings of the Thirteenth Meeting of the British Association for the Advancement of Science.**

*Catalogue of the Stars.*—Dr. Robinson, of Armagh, announced that the reductions necessary to form this catalogue were completed, and that it embraced the places of ten thousand stars, with the corrections necessary to determine their places at a subsequent epoch.†

*Action of the Chemical rays in Light upon Chlorine.*—Professor Draper, of New York, finds that chlorine gas which has been exposed to light, possesses qualities not found in chlorine made and kept in the dark. It unites rapidly with hydrogen. The chemical rays corresponding to the indigo in the spectrum, produce this effect in the greatest degree. The effect is permanent, and the light itself is deprived of the rays thus absorbed by the gas.

*On the heat of Combination.*—The following important law was developed, in a series of experiments, by Dr. Andrews, of Belfast:—"When one base displaces another from any of its neutral combinations, the heat evolved, or abstracted, is always the same when the base is the same; or, in other words, the change of temperature which

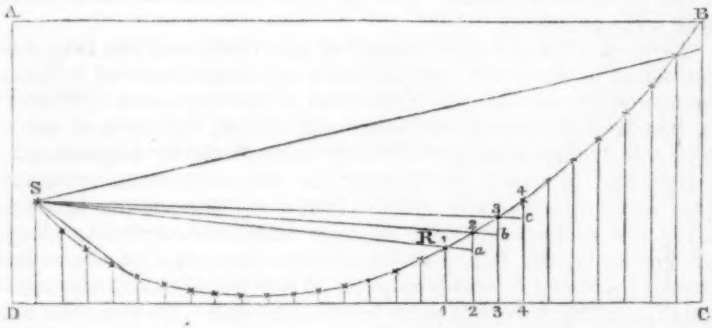
* This abstract of the principal proceedings of some of the sections of the British Association, is made from the report in the London Athenæum for August and September, 1843.

† Nearly ten thousand dollars were expended in the computation of this catalogue, and three thousand have been appropriated for its publication.

occurs during the substitution of one base for another, in any neutral compound, depends wholly on the bases, and is, in no respect, influenced by the acid element of the combination."

*Decomposition of Carbonic Acid under the light of the Sun.*—The decomposition of carbonic acid, and the alkaline carbonates, by the leaves of plants under the light of the sun, is found, by Professor Draper, of New York, to take place most rapidly in the yellow rays, the rays of highest illuminating power in the spectrum.*

*Form of Lecture Rooms.*—Mr. Scott Russell, of Edinburgh, describes the arrangement of a lecture room, the lecturer being placed in the focus of what he calls a curve of equal hearing, or isacoustic curve, and the heads of the hearers by the arrangement of the benches occupying points of the same curve. The arrangement is shown in the annexed diagram.




Let A, B, C, D, represent the vertical section of a building for public speaking; S, the height of the speaker on his platform; D, C, the floor of the building: then, for the purpose that all the auditors should hear and see equally well, they should be placed on the line, S, R, B, of the isacoustic curve. This curve is constructed in the following manner: D, C, is first divided into equal parts, to represent the usual breadth of a sitting, and vertical lines are drawn through these points. R, being the place of the auditor 1; the place of auditor 2 behind him, is assigned thus—join S, R, and produce it to *a*—from *a* upwards set off *a* 2 = 9 inches, and 2 is the proper height of the next spectator. Then join S 2, produce it to *b*, and set off *b* 3 = 9 inches, and 3 is the place of the third spectator; and so on for the place of every spectator. Such was the vertical section of the building. The horizontal section was either circular, or polygonal, having the speaker at the centre. This form had been found perfectly successful in affording the highest degree of comfort both to hearer and speaker.†

* See also Bulletin of Amer. Philos. Soc. vol. iii, Centennary Meetings.

† This principle was applied, by Professor A. D. Bache, in the construction of two of the rooms in the building for the Collegiate Department of the University of Pennsylvania in 1830.

*Expenditure for the promotion of Science.*—The sum already appropriated to further the prosecution of original researches, calculations, for the publication of researches, &c., by the British Association, amounts to more than forty thousand dollars.

*Observations on the direction and force of Wind.*—Mr. Snow Harris deduces from the discussion of observations made at Plymouth with Whewell's anemometer, that there is, on the average, a general motion of the air from south to north. The observations with Osler's anemometer show a general tendency to two maxima, and two minima in the force of the wind during every twenty-four hours, the force increasing as the barometer falls, and *vice versa.*

*Tides of the eastern coast of Scotland.*—The result of simultaneous observations at twenty-one stations on the eastern coast of Scotland, were communicated by Mr. Scott Russell. At particular stations observations of the height of the tide were made every five minutes for one or more lunations. The general results in regard to the tide wave were as follows:

"As in the former observations of the Clyde and the Dee, it had been found in this series, that the form and dimensions of a channel produce important changes in the form of the tide wave. Where the sea was deep, and the shore open and abrupt, the form of the tide wave was symmetrical, and of the form predicted by Laplace, where he says, that in rising and falling, the water covers in equal times equal areas of a vertical circle. This is the form of the ocean tide wave; but, on approaching a shallow shore, and traveling along a shelving coast, the tide wave undergoes two changes—its summit becomes displaced forwards in time, its horizontal chords become dislocated, and the wave ceases to be symmetrical. This peculiar dislocation and displacement are characteristic of a littoral tide, and in the case of running streams, the currents still further affect the tide wave, and give to it a peculiar distortion characteristic of fluvial tides. To these were further added the exaggeration and elevation of the tide, by means of narrow channels. All these phenomena were fully proved by the present series of observations. The author of this paper also considers it to have been fully established by the observations on the Frith of Forth, that there exists on the eastern coast, satisfactory evidence of the presence of a second tide wave in that part of the German Ocean, and that the southern tide wave, a day older than the northern tide wave, sensibly affects the phenomena of that part of the coast: to this he attributes the double tides of the Frith of Forth."

*Destruction of Elasticity by small strains.*—Mr. Hodgkinson infers from his experiments, and those of Mr. Fairbairn, on different materials, including wrought and cast-iron, stone and wood, that the "sets" produced in bodies are proportional to the squares of the weights applied; and, therefore, that small weights produce a permanent set in bodies.*

* This article will be given in full.

*Temperature of the Air at different heights.*—The following is a description of the telegraph thermometer devised by Professor Wheatstone, of London, and to be applied in their experiments with "captive balloons," by the committee of the Association:

"The telegraph thermometer which is intended to be carried up by the balloon, weighs, with its case, about four pounds. It is thus constructed: the movement of a small clock causes a vertical rack to ascend and descend regularly in six minutes, three minutes being occupied in the ascent, and three in the descent. The rack carries a fine platina wire, which moves within the tube of a thermometer; the extent of motion of this wire corresponds with 28° of the thermometric scale, but it is capable of adjustment, so that it may pass over any 28° of the range. Two very fine copper wires, covered with silk, and of sufficient length to reach from the ground to the balloon, when at its greatest elevation, are connected with the instrument in the following manner: the extremity of one wire is connected with the mercury in the bulb of the thermometer, and that of the other wire with the frame of the clock, which is in metallic continuity with the platina wire. On the ground, the lower extremities are joined together; in the wire whose opposite end is connected with the mercury in the thermometer, a sensible galvanometer is interposed, and in the course of the other wire a single, very small, voltaic element is introduced. The galvanometer having been properly adjusted to its zero point, it will remain so during the time that the platina wire is not in contact with the mercury in the tube, but the needle will deviate so soon as the contact takes place, and will remain deflected until contact is again broken during the ascent of the rack. During each half second of time, corresponding with the beats of the clock, the wire moves through the 360th part of its range, and a different point of the range consequently corresponds with a different beat, or half second of each alternate three minutes. If, therefore, an observer below be furnished with a chronometer, timed to coincide with the clock in the balloon above, and note at what instant the needle of the galvanometer is deflected, he may infer from that observation the temperature indicated by the thermometer in the balloon; for, according to the different expansion of the mercury in the thermometer, the contact is broken at a different half second. Should the rates of the two time pieces not exactly correspond at the conclusion of a series of observations, the results will not be vitiated, as a correction may be easily made. It is intended to add to this apparatus a wet bulb thermometer; this will involve only the addition of another platina wire to the rack, and of another insulated wire, reaching from the balloon to the earth, with its interposed galvanometer.

"For other meteorological instruments, the indications of which are to be transmitted to a distance, I occasionally employ the agency of electro-magnetism to ring a bell, to mark with a type, or pencil, &c.; but for the purpose in question, such methods cannot be so conveniently employed as the deflexion of the needle of a galvanometer

on account of the necessity of having the long conducting wire extremely fine, in order to avoid adding too much to the weight of the balloon. If the electro-motive force of the rheomotor were increased, which it would be necessary to do were stronger currents required, sparks would occur at the surface of contact of the mercury, which would produce injurious effects."

*Two new metals.*—Professor Mosander in examining the mineral yttria has found two new metallic oxides, the bases of which he calls erbium and terbium.

*Geological survey of Great Britain.*—Attached to the corps which is carrying on the trigonometrical survey of Great Britain, are geologists who carry on simultaneously with the trigonometrical operations a geological survey. Characteristic specimens of the different strata, and of the fossils contained in them, are deposited in the "Ordnance Museum," which it is intended, eventually, to throw open to the public.

*Motion of glaciers.*—Mr. Hopkins, with a view to elucidate the theory of the motion of the glaciers, made the following experiments:

"A slab of sandstone, prepared to be laid down as a part of a common flagstone pavement, was so arranged as to be easily placed at any proposed inclination to the horizon. The surface of the slab, so far from being polished, retained the grooved marks of the instrument with which the quarry-man had shaped it. A quantity of ice was placed on the slab, within a frame nearly a foot square, intended merely to keep the ice together, and not touching the slab, with which the ice alone was in contact. The following were results obtained in one set of experiments, the ice being loaded with a weight of about 150 lbs.:

| Inclination of the planes, | 3° | 6° | 9° | 12° | 15° |
|---|---|---|---|---|---|
| | Inches. | | | | |
| Mean space for one hour, | 0.31 | .62 | .96 | 2. | 2.5 |

When the weight was increased, the rate of motion was also increased. The least inclination at which sensible motion would take place, was not determined; but it was ascertained that it could not exceed *half a degree* in the case of a smooth but unpolished surface. With a *polished* surface of a marble slab, the motion of the ice indicated a deviation from horizontality with as much sensibility as water itself. It will be observed, in the results above given, that (1) the motion was unaccellerated; and (2) it increased with the inclination, and (when the inclination was not greater than nine or ten degrees,) in nearly the same ratio; and (3) the rate of movement was of the same order of magnitude as in actual glacial motion, which may be stated generally, in cases yet observed, never to exceed two feet a day. The extremely small friction between the plane and the ice, indicated by the small inclination necessary to produce motion, was manifestly due to the circumstance of the lower surface of the ice being in a state of gradual disintegration, which, however, was extremely slow, as

proved by the small quantity of water proceeding from it. In the application, therefore, of these results to the case of actual glaciers, it was necessary to show that the temperature of their lower surfaces could not generally be less than 32° Fahr. Such, the author stated, must necessarily be the case, unless the conductive power of ice was greater than it was deemed possible that it could be."

The temperature at which the experiments were made is not stated.

*Earthquakes in Scotland.*—In the course of the year from July 1842 to July 1843, no less than thirty slight shocks of earthquakes have occurred at Comrie, in Perthshire.

*Permanent expansion of solids by heat.*—Mr. Scott Russell states that cast and malleable iron and brass undergo a permanent expansion when heated, not returning, on cooling, to their former dimensions. This is contrary to the results hitherto obtained in regard to these bodies.

*Meteorological report.*—The abstract, by Col. Sabine, of the report by Sir J. F. W. Herschel, from the committee on the reduction of meteorological observations, embracing the series of equinoctial and solsticial observations for 1835 to 1838 both inclusive, cannot be abridged, and will be given in full in a future number.

*Diurnal changes of the magnetic elements.*—The reductions of the magnetic observations at Dublin, made under the direction of Professor Lloyd, exhibit the following facts in regard to diurnal changes at that place. The horizontal intensity has two maxima and two minima during the twenty-four hours, the former at 5 A. M. and 6 P. M., and the latter between 1 and 3 A. M. and 10 A. M. The first named are small compared with the second, and disappear in the summer months; in the winter the evening maximum appears to divide into two. The time of occurrence of the morning maximum depends upon the hour of sun-rise. The daily range of force in July is .0045 of the whole intensity, and in January but .0008: the total intensity varies but little through the day. It is least about 9 A. M., and then increases, having a double maximum in the afternoon. The chief apparent changes in the two components of the intensity, the horizontal and vertical, are due to changes of dip (inclination.) The dip is greatest between 10 and 10½ A. M., and least about 6 P. M. The daily range in the early part of the year is about two minutes, and increases to more than double that amount in summer. The diurnal variation (change of declination) follows a different course at different periods of the year. The mean change for the whole year shows a small easterly motion of the north end of the needle in the morning, attaining a maximum about 7 A. M. The north end of the magnet then moves rapidly westward, attaining its extreme position at 1h. 10m. P. M.: the easterly deviation again becomes a maximum about 10 P. M. The mean daily range is about 9.3 minutes. During the summer months the morning maximum at 7 A. M. is more marked, and the

evening maximum disappears, while in winter the reverse is the case. The greatest daily range is in summer, and about 13.7 minutes; the least, in winter, and about 7.2 minutes. The diurnal changes in the direction of the magnetic force appear to connect it with the diurnal movement of the sun.

*Artificial magnets.*—Dr. Scoresby finds that for large magnets consisting of many bars, or of heavy masses, the best cast-steel made as hard as possible, is the most effective material; while, for small magnets, or thin compass needles, other steel, or cast-steel tempered, is better. The dimensions of a magnetic bar being doubled, and the bar saturated, the effective force is increased only five or six times. The rule in regard to the use of hard cast-steel for bar magnets does not hold with compound horse-shoe magnets, a softer material being required to produce the most powerful combination with this form of magnet.

*Report of the committee on the form of Ships.**—This report, by Mr. Scott Russell, includes 20,000 observations, on more than one hundred vessels of different forms. It is understood to be now ready for publication. One of the general laws announced by Mr. Russell, is that each velocity of motion has a corresponding form and dimension producing with it the least resistance. In a comparison of four different vessels of the same length, breadth, depth, area, and form of midship section, and loaded to the same weight, displacement, and draught of water, the form of the water-lines being the only difference in the models, the following results were obtained. No. 1, was of the wave form of water-line; No. 3, the "old form," nearly the reverse of the former; No. 2, intermediate between No. 1 and 3, and No. 4, intermediate between No. 1 and 2.

| Miles per hour. | Resistance in pounds. | | | |
|---|---|---|---|---|
| | No. 1. | No. 4. | No. 2. | No. 3. |
| 3 | 10 | 11.3 | 12 | 12 |
| 4 | 18 | 21 | 22 | 23 |
| 5 | 28 | 35 | 38 | 42 |
| 6 | 39 | 56 | 61 | 72 |
| 7 | 52 | 84 | 96 | 129 |

* These experiments have occupied more than five or six years, and have cost more than four thousand dollars.

# INDEX.


Acid of Commerce, purification of hydrochloric . . 143
Acid, decomposition of carbonic, under the heat of the sun, . 419
Aerial Navigation, principles of . . . 132, 202
Air, temperature of the, at different heights, . . 421
Alloy, Mallet on metallic . . . . 325
Alloys, elasticity, &c. of . . . . 345
Amalgum of sodium, a galvanic pair, . . . 346
Analysis, application of the electrotype process in conducting organic 339
Aqueducts and Viaducts, Vignoles' lecture on . . 23
Architecture and Gardening, Loudon on landscape . 47, 89, 182, 265
Artificial magnet, . . . . 424
Asphaltic pavements, report on . . . 147
Axles, causes of the breakage of the journals of railway . 178
———, description of Hancock's railway . . 181
———, experiments on the strength of solid and hollow . 332

Bakewell, T. W. on strength of cylindrical boilers, . . 100, 206
Beacon erected at the harbor of Black Rock, description of a wrought-iron, by Capt. W. H. Swift, . . . . 385
Bicarbonate of soda, preparation of . . . 72
Bissell's pneumatic car, or carriage, springs, report on . . 168
Blow-pipe, Moss on the . . . . 104
Boiling point of liquids, . . . . 358
Brass and copper, covering with platina . . 357
———————, tinning and zincing, by the moist way, . 358
Breakwater, Norton's lotus floating . . 181
Bricks, unburnt, from the Pyramids of Daskmoor, . . 181
Bridges, proposal to improve the design of arched . . 80
Bronzing, galvanic . . . . 356
Buckingham palace, description of roofs over . . 98

Carbonic acid, decomposition of, under the light of the sun, . 419
Carriage springs, report on Bissell's pneumatic car, or . 168
Carriages, injuries done to roads by the passage of . . 251
Caspian Sea, level of the . . . 346
Cemeteries, public, Trautwine on . . . 46
———————, Loudon on . . . 47, 88, 182, 265
Chemical rays in light upon chlorine, action of the . . 419
Chlorine, action of the chemical rays in light upon . ib
Civil engineering, Vignoles' lecture on . . 20, 73, 170, 246, 302, 390
Combination, on the heat of . . . 419
Comets, heat from . . . . 345
Copper and brass, covering with platina . . . 357
———————, tinning and zincing in the moist way, . 358
Copper, test for . . . . 359
Corona and beads during a solar eclipse, . . 347
Curves, Vignoles' lecture on railway . . . 20

Daskmoor, unburnt bricks from the pyramids of . . 181
Decomposition of carbonic acid under the light of the sun, . 419
Dover, Gen. Pasley on the mining operations near . . 28
Dynamometer for measuring steam, or water, power, . . 275

Earthquakes in Scotland, . . . 423
Eclipse, corona and beads during a solar . . . 347
Elasticity, &c. of alloys, . . . 345
——————— destruction of by small strains, . . 420

Electricity evolved by the friction of water and steam on other bodies, 141
———, from steam, . . . . 347
———, resistance of earth to the motion of . . . 345
Electro-chemical silvering, . . . . 356
Electrotype process in conducting organic analysis, application of the . 359
Ellet, jr., C. on cost of transportation on railroads, . . 316, 361
Etching on hardened steel, &c. by electricity, . . . 340
Excavator, Otis' steam . . . 175, 309
Expansion of solids by heat, permanent . . . 423
Explosion of the Dover cliff, account of . . . 28
Explosions of steam boilers, . . . . 139
Explosive force of oxygen and hydrogen gases, experiments on the 210

Founding, on the processes of iron . . . 56, 116, 191, 269
Fires, on colored . . . . 358
Flying machine, steam power of Henson's . . . 281
—— machines . . . . 336
Friction of water and steam against other bodies, on the electricity evolved by 141

Franklin Institute.

Committee on Science and the Arts.
Report on the best modes of paving highways, . . 145, 217
———— Bissell's pneumatic car, or carriage spring, . 168
Committee on Exhibitions.
Address delivered at the close of the thirteenth exhibition, by John Wiegand, Esq., Chairman, . . . . 394
Report on the thirteenth exhibition of American Manufactures, . 397

Galvanic Bronzing, . . . . 356
—— induction, . . . . 344
—— pair, amalgam of sodium, a . . . 346
Galvanized iron, . . . . 144
Gardening and architecture, Loudon on landscape . 47, 89, 182, 265
Gases, experiments on the explosive force of oxygen and hydrogen 210
Geological survey of Great Britain, . . 422
Gilding and silvering by immersion, methods of . . 142
——— gilding by precipitation—*patent*, . . 287
Glaciers, motion of . . . . 422
Glass, images on . . . . 347
Glue, Jefferies' marine . . . 197
Greenwich pier, account of the failure of the . . 180
Great Britain steamer, description of the . . . 306
————, geological survey of . . . 422

Heat from comets, . . . . 345
—— of combination, on the . . 419
——, permanent expansion of solids by . . 423
Henson's flying machine, steam power of . . 281
Highways, report on the best modes of paving . . 145, 217
Hot-blast, legal decision on Neilson's patent, . . 135
Hydrochloric acid of commerce, purification of . . 143
Hydro-electric currents from thermo-electric, . . 345
Hydrogen gases, experiments on the explosive force of oxygen and . 210

Images on Glass . . . . 347
———— Resin, . . . . 346
Iron beacon erected at the harbor of Black Rock, description of a wrought, by Capt. W. H. Swift, . . . . 385
Iron by the hot-blast, legal decision on Neilson's patent for making 135
—— founding, on the processes of . . 56, 116, 191, 269
—— galvanized, . . . . 144
—— rails, making direct from the ore, . . . 125
—— rails for railways, Trautwine on . . . 1

Jefferies' marine glue, . . . . 197
Jupiter's moons, . . . . 346

Lamp burners, on the perfect ventilation of . . 128
Lead, on the action of water on . . . . 284
Liquids, boiling point of . . . . 358
Lecture rooms, form of . . . . 419
Light, action of the chemical rays in, upon chlorine, . ib.
—— of the sun, decomposition of carbonic acid under the . ib.
Long Island Sound, description of a wrought-iron Beacon erected at the harbor of Black Rock, by Capt. W. H. Swift, . . . 385
Lotus floating breakwater, Norton's . . 181
Loudon's principles of landscape gardening and architecture, applied to public cemeteries, . . . . 47, 88, 182, 265

Magnetic elements, diurnal changes of the . . . 423
Magnets, artificial . . . . 424
Marine Glue, Jefferies' . . . . 187
Metal, another new . . . . 345
Metals, two new . . . . 422
Metallic alloy, . . . . 325
Meteorological observations, . . . 216, 288, 360
———— report . . . 423
Mining operations near Dover, Gen. Pasley on the . 28
Morin's experiments on turbines, . . 234, 279, 370
Morris, E. on a new application of railways, . . 313
———— experiments on the useful effects of turbines in the United States, 377
Möser's discovery, effect neither due to light nor heat, . . 68, 110
Moss, T. F. remarks on the blow-pipe, . . 104

Nautical inventions, Clement's . . . 348
Navigation, principles of ærial . . . 132, 202
Neilson's patent hot-blast, legal decision on . . 135
Norton's lotus floating breakwater, . . . 181

Oil, of calming the waves of the sea, experiments to verify the property ascribed to 341
Ores used at Freiburg, . . . . 109
Organic analysis, application of the electrotype process in conducting 339
Otaheite, tides at . . . . 343
Otis' steam excavator, . . . . 175, 309
Oxygen and hydrogen gases, experiments on the explosive force of . 210

Palladium, its extraction, alloys, &c., . . 329
Pasley, Gen. on the mining operations near Dover, . . 28
Paving highways, report on the best modes of . . 145, 217
——— roads, &c. with wood—*patent*, . . . 286
Pavements, asphaltic, report on . . . 147
————, stone, report on . . . 160
————, tesselated, ancient and modern, . . 40
————, wooden, report on . . . 149
Photographic processes, improvements on . . 187
Pier, account of the failure of the Greenwich . . 180
Platina, covering copper and brass with . . 357
Poncelet M. on stability of revetments, and of their foundations, . 10
Public cemeteries, Trautwine on . . . 46
————, Loudon on . . . 47, 88, 182, 265
Pyramids of Daskmoor, unburnt bricks from the . . 181

Railroads, Ellet on cost of transportation on . . 316, 361
Railway axles, causes of the breakage of the journals of . 178
——— axle, description of Hancock's . . . 181
——— curves, Vignoles' lectures on . . 20
——— estimates, Vignoles' lectures on . . 76, 170
——— crossing by common roads at same level . . 85

Electricity evolved by the friction of water and steam on other bodies, 141
———, from steam, 347
———, resistance of earth to the motion of 345
Electro-chemical silvering, 356
Electrotype process in conducting organic analysis, application of the 339
Ellet, jr., C. on cost of transportation on railroads, 316, 361
Etching on hardened steel, &c. by electricity, 340
Excavator, Otis' steam 175, 309
Expansion of solids by heat, permanent 423
Explosion of the Dover cliff, account of 28
Explosions of steam boilers, 139
Explosive force of oxygen and hydrogen gases, experiments on the 210

Founding, on the processes of iron 56, 116, 191, 269
Fires, on colored 358
Flying machine, steam power of Henson's 281
——— machines 336
Friction of water and steam against other bodies, on the electricity evolved by 141

Franklin Institute.

Committee on Science and the Arts.
Report on the best modes of paving highways, 145, 217
——— Bissell's pneumatic car, or carriage spring, 168
Committee on Exhibitions.
Address delivered at the close of the thirteenth exhibition, by John Wiegand, Esq., Chairman, 394
Report on the thirteenth exhibition of American Manufactures, 397

Galvanic Bronzing, 356
——— induction, 344
——— pair, amalgam of sodium, a 346
Galvanized iron, 144
Gardening and architecture, Loudon on landscape 47, 89, 182, 265
Gases, experiments on the explosive force of oxygen and hydrogen 210
Geological survey of Great Britain, 422
Gilding and silvering by immersion, methods of 142
——— gilding by precipitation—*patent*, 287
Glaciers, motion of 422
Glass, images on 347
Glue, Jefferies' marine 197
Greenwich pier, account of the failure of the 180
Great Britain steamer, description of the 306
———, geological survey of 422

Heat from comets, 345
——— of combination, on the 419
———, permanent expansion of solids by 423
Henson's flying machine, steam power of 281
Highways, report on the best modes of paving 145, 217
Hot-blast, legal decision on Neilson's patent, 135
Hydrochloric acid of commerce, purification of 143
Hydro-electric currents from thermo-electric, 345
Hydrogen gases, experiments on the explosive force of oxygen and 210

Images on Glass 347
——— Resin, 346
Iron beacon erected at the harbor of Black Rock, description of a wrought, by Capt. W. H. Swift, 385
Iron by the hot-blast, legal decision on Neilson's patent for making 135
——— founding, on the processes of 56, 116, 191, 269
——— galvanized, 144
——— rails, making direct from the ore, 125
——— rails for railways, Trautwine on 1

Jefferies' marine glue, . . . . . 197
Jupiter's moons, . . . . . 346

Lamp burners, on the perfect ventilation of . . . 128
Lead, on the action of water on . . . . 284
Liquids, boiling point of . . . . . 358
Lecture rooms, form of . . . . . 419
Light, action of the chemical rays in, upon chlorine, . . ib.
—— of the sun, decomposition of carbonic acid under the . ib.
Long Island Sound, description of a wrought-iron Beacon erected at the harbor of Black Rock, by Capt. W. H. Swift, . . . . 385
Lotus floating breakwater, Norton's . . . 181
Loudon's principles of landscape gardening and architecture, applied to public cemeteries, . . . . . 47, 88, 182, 265

Magnetic elements, diurnal changes of the . . . 423
Magnets, artificial . . . . . 424
Marine Glue, Jefferies' . . . . . 187
Metal, another new . . . . . 345
Metals, two new . . . . . 422
Metallic alloy, . . . . . 325
Meteorological observations, . . . 216, 288, 360
———— report . . . . . 423
Mining operations near Dover, Gen. Pasley on the . . 28
Morin's experiments on turbines, . . . 234, 279, 370
Morris, E. on a new application of railways, . . . 313
———— experiments on the useful effects of turbines in the United States, 377
Möser's discovery, effect neither due to light nor heat, . . 68, 110
Moss, T. F. remarks on the blow-pipe, . . . 104

Nautical inventions, Clement's . . . . 348
Navigation, principles of ærial . . . . 132, 202
Neilson's patent hot-blast, legal decision on . . . 135
Norton's lotus floating breakwater, . . . 181

Oil, of calming the waves of the sea, experiments to verify the property ascribed to 341
Ores used at Freiburg, . . . . . 109
Organic analysis, application of the electrotype process in conducting 339
Otaheite, tides at . . . . . 343
Otis' steam excavator, . . . . 175, 309
Oxygen and hydrogen gases, experiments on the explosive force of . 210

Palladium, its extraction, alloys, &c., . . . 329
Pasley, Gen. on the mining operations near Dover, . . 28
Paving highways, report on the best modes of . . 145, 217
———— roads, &c. with wood—*patent*, . . . 286
Pavements, asphaltic, report on . . . . 147
————, stone, report on . . . . 160
————, tesselated, ancient and modern, . . 40
————, wooden, report on . . . . 149
Photographic processes, improvements on . . . 187
Pier, account of the failure of the Greenwich . . 180
Platina, covering copper and brass with . . 357
Poncelet M. on stability of revetments, and of their foundations, . 10
Public cemeteries, Trautwine on . . . . 46
———— ————, Loudon on . . . 47, 88, 182, 265
Pyramids of Daskmoor, unburnt bricks from the . . 181

Railroads, Ellet on cost of transportation on . . 316, 361
Railway axles, causes of the breakage of the journals of . 178
———— axle, description of Hancock's . . . 181
———— curves, Vignoles' lectures on . . . 20
———— estimates, Vignoles' lectures on . . . 76, 170
———— crossing by common roads at same level . . 85

Railways, Morris on a new application of . . . . 313
———, Trautwine on rails for . . . . 1
———, Vignoles' lectures on the upper works of . . . 24, 73
———, wheels and tires of wheels for—*patent*, . . . 212
———, working expenses of, Vignoles' lectures on . . . 246, 302, 390
Resin, images on . . . . 346
Revetments, and of their foundations, Poncelet on the stability of . . 10
Roads by the passage of carriages, injury done to . . . 251
Roofs over Buckingham palace, description of . . . 98

Science, hasty generalizations in . . . . 347
———, expenditure for the promotion of . . . 420
Scotland, tides on the eastern coast of . . . 420
———, earthquakes in . . . . 423
Sea, new mode of measuring the . . . . 344
Ships, report of committee on the form of . . . 424
Sillomètre, on the . . . . 348
Silver and other metals from their compounds, separating—*patent*, . 214
Silvering and gilding by immersion, methods of . . . 142
———, electro-chemical . . . . 356
Soda, preparation of bicarbonate of . . . . 72
Sodium amalgum of, a galvanic pair, . . . . 346
Solar eclipse, corona and beads during a . . . 347
—— spectrum, on the parathermic rays of the . . . 187
Solids, permanent expansion of, by heat, . . . 423
Speaking machine, . . . . 345
Spring contractor, Lieut. Rankine's . . . . 338
———, report on Bissell's pneumatic car, or carriage, . . . 168
Stanhope's composition for covering roofs, . . . 98
Stars, catalogue of the . . . . 418
Steam boilers, on the strength of cylindrical . . . 54, 100, 209, 279
———, explosions of . . . . 139
Steam and water against other bodies, on the electricity evolved by the friction of 141
—— excavator, Otis' . . . . 175, 309
——, electricity from . . . . 347
——, or water, power, dynamometer for measuring . . . 275
—— power for Henson's flying machine, . . . 281
Steamer, description of the Great Britain . . . 306
Stockings, drawers, &c., manufacturing—*patent*, . . . 286
Steel plates, &c., etching by electricity on hardened . . . 349
Stone pavements, report on . . . . 161
Sun, decomposition of carbonic acid under the light of the . . 419
Survey of Great Britain, geological . . . 422
Swift, Capt. W. H., description of a wrought-iron beacon erected at the harbor of Black Rock, by . . . . 385

Specifications of Patents.

Drawers, hose, &c., manufacturing—*Keene's*, . . . 286
Oxides of metals, separating silver, &c.—*Mullin's*, . . 214
Paving roads, ways, and other surfaces—*Dotchin's*, . . 286
Plating by precipitation—*Talbot's*, . . . 287
Weighing machine—*Cotton's*, . . . 285
Wheels and tires of wheels for railways—*Banks'*, . . 212

Temperature of the air at different heights, . . . 421
Tesselated pavements, ancient and modern, . . . 40
Test for copper, . . . . 359
Thermo-electric from hydro electric currents, . . . 345
Tides at Otaheite, . . . . 343
—— of the eastern coast of Scotland, . . . 420
Timber, preserving by Payne's patent, . . . 88
Tinning and zincing copper and brass in the moist way, . . 358
Trautwine J. C. on public cemeteries, . . . 46
———— ———— rails for railways, , . . . 1

Transportation on railroads, Ellet on cost of . . . 316, 361
Turbines, Morin's experiments on water-wheels called . . . 234, 289, 370
————, in the United States, experiments on the useful effect of by E. Morris, C. E., 377

Viaducts and Aqueducts, Vignoles' lectures on . . . 23
Ventilation of lamp-burners, on the perfect . . . 128
Vignoles' lectures on civil engineering, . . . 20, 73, 170, 246, 302, 390

Water, action of, on bodies, . . . 345
—— and steam against other bodies, on the electricity evolved by the friction of 141
—— on lead, on the action of . . . 284
—— power, dynamometer for measuring steam, or . . 275
Water-wheels, coefficient of laboring force in . . . 62
————wheel, Mallet's close-breast for an overshot . . 177
————wheels, Morin's experiments on . . . 234, 289, 370
————————, Morris' experiments on, in the United States, . 377
Waves of the sea, experiments to verify the property ascribed to oil of calming the 341
Weighing machine—*patent*, . . . 285
Well sinking, legal decision regarding . . . 312
Wheels and tires of wheels for railways—*patent*, . . . 212
White lead, making—*patent*, . . . 214
Winds, observations on the direction and force of . . . 420
Wood, paving roads, &c., with—*patent*, . . . . 214
Woolen factory for Turkey, . . . . 311
Wooden pavements, report on . . . . 149

Zincing and tinning copper and brass in the moist way. . . . 358